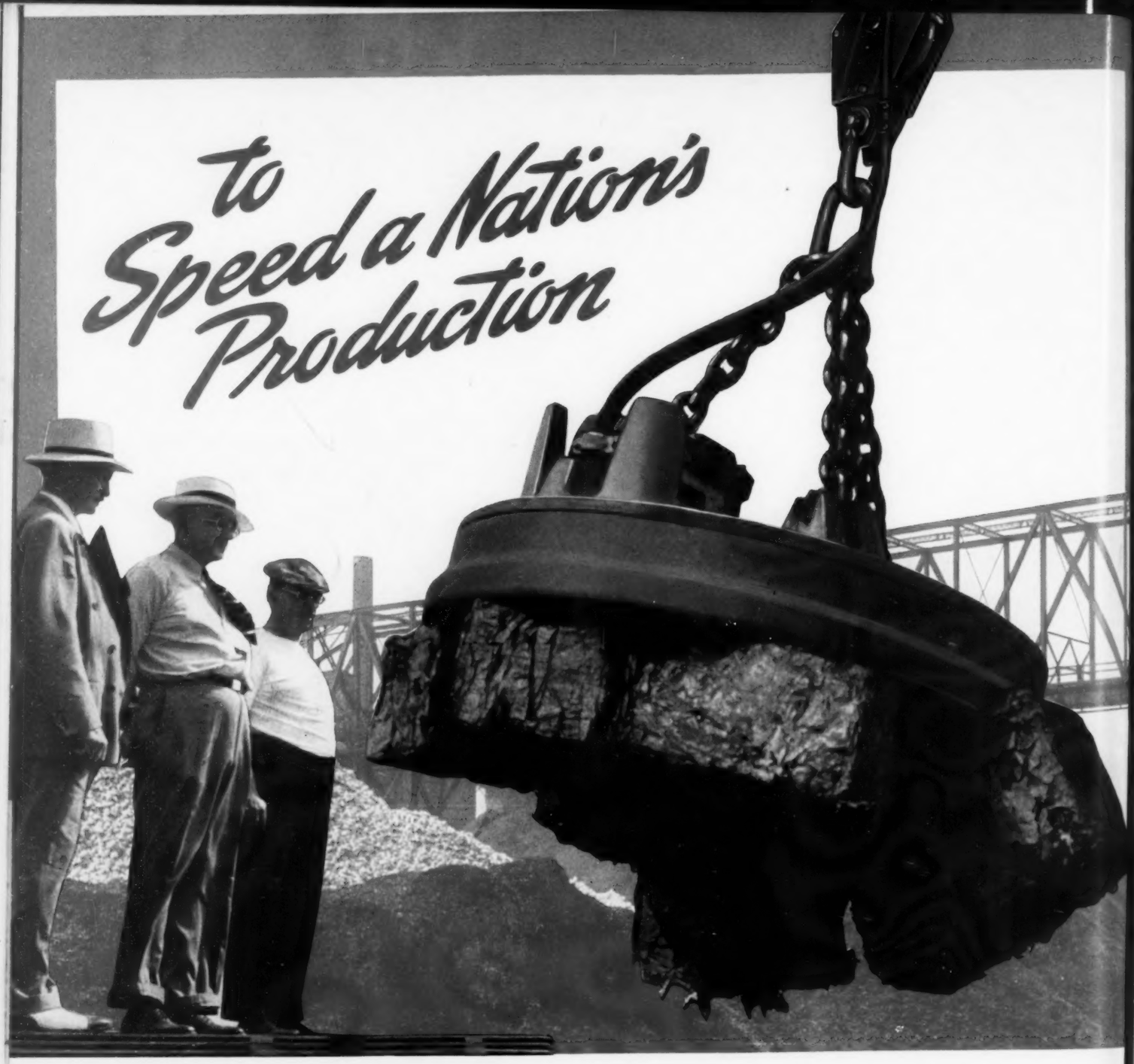
Iron and Steel ENGINEER

ENGINEERING SERVICE
TO THE IRON AND STEEL
INDUSTRY SINCE 1907

1010 EMPIRE BUILDING | APRIL, 1942 | PITTSBURGH, PA.

MAY 1 - 1942

110" FOUR HIGH REVERSING PLATE MILL
DESIGNED AND BUILT BY
MESTA MACHINE COMPANY, PITTSBURGH, PA.



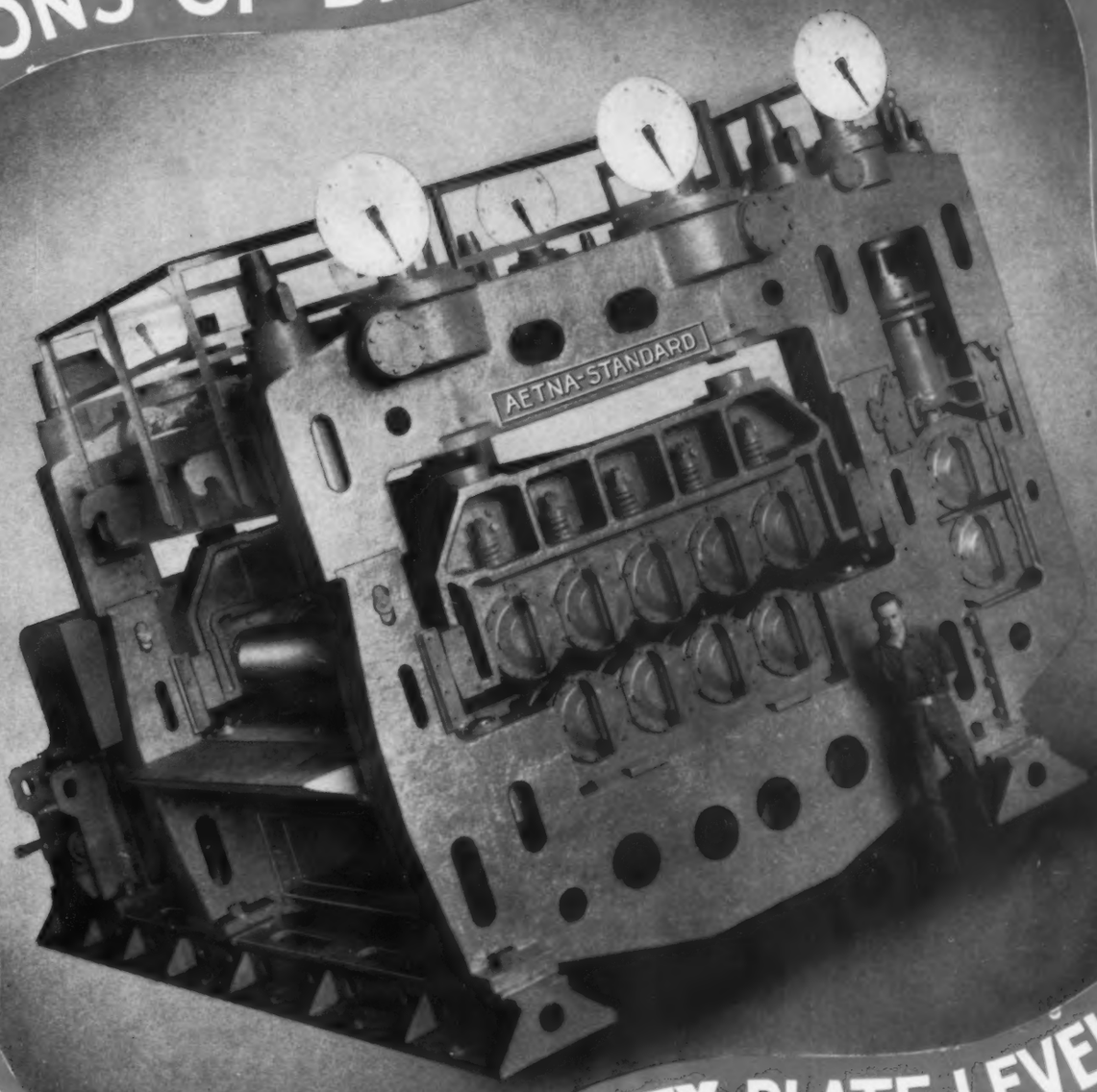
THE giant 77" lifting magnet—the world's largest—is just one of the many types of C-H Supermagnets that are working day in and day out in the nation's leading plants getting today's vital job done.

By utilizing a crane's "reserve" capacity, Supermagnets afford the most economical and immediate method of gaining maximum metal handling production. Supermagnets stand up day after day, year after year, giving unfailing dependability to maintain 24-hour schedules. And at the same time provide, dollar for dollar, the greatest lifting power and efficiency to be had in the lifting magnet field.

Get all the facts about the Cutler-Hammer line of lifting magnets. Watch a Supermagnet at work on a tough job—the tougher the better—then try Supermagnets yourself and get the greater metal-handling speeds, lower operating and demurrage costs they bring. CUTLER-HAMMER, Inc., 1257 St. Paul Avenue, Milwaukee, Wisconsin. *Associate:* Canadian Cutler-Hammer, Ltd., Toronto, Ontario.

CUTLER-HAMMER
SUPERMAGNETS
C-H

200 TONS OF BRAINS & BRAWN



AETNA'S NEW HEAVY DUTY PLATE LEVELLER

LEVELS PLATE UP TO 132" WIDE!

Aetna's NEW 140 inch Heavy Duty Plate Leveller is designed to handle alloy plate from 5/8" to 1 1/4" thick, up to 132" width at a speed of one hundred to three hundred feet per minute. Consult our engineers for complete information.

ASSOCIATED COMPANIES
HEAD, WRIGHTSON & COMPANY, LIMITED, THORNABY-ON-TEES, ENGLAND
JOHN INGLIS COMPANY, LIMITED, TORONTO, ONTARIO, CANADA

The **AETNA-STANDARD**
ENGINEERING COMPANY
GENERAL OFFICES
YOUNGSTOWN, OHIO, U.S.A.

Designers and Builders to the Steel, Non-ferrous and Chemical Industries

IRON AND STEEL ENGINEER

APRIL • 1942

VOL. XIX NO. IV

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Long Mathews engineering hours are devoted entirely these days to the development of equipment for handling war material so that our prime movers can get it to where it is needed in less time.

If you are manufacturing war material, or anything vital to the success of the war effort, you can get Mathews Conveyers to handle that material. Rely as usual on your Mathews Engineer.

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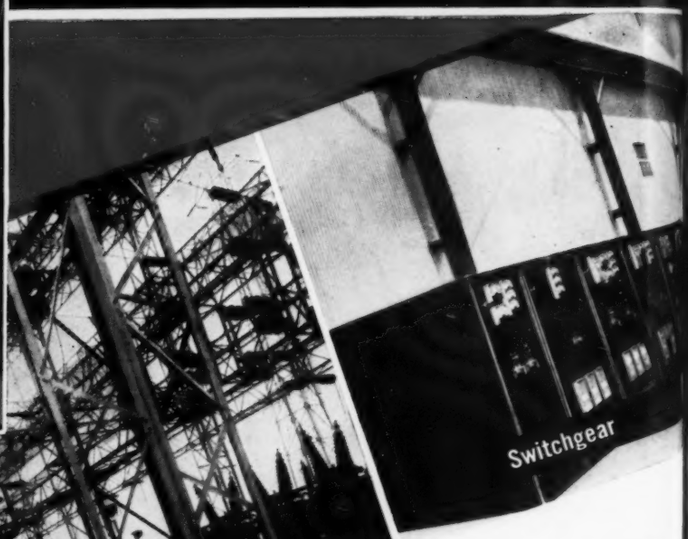
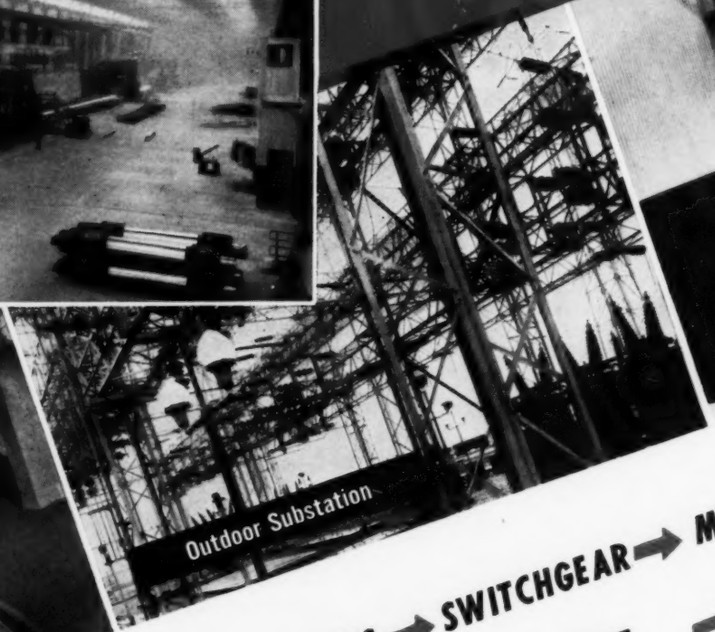
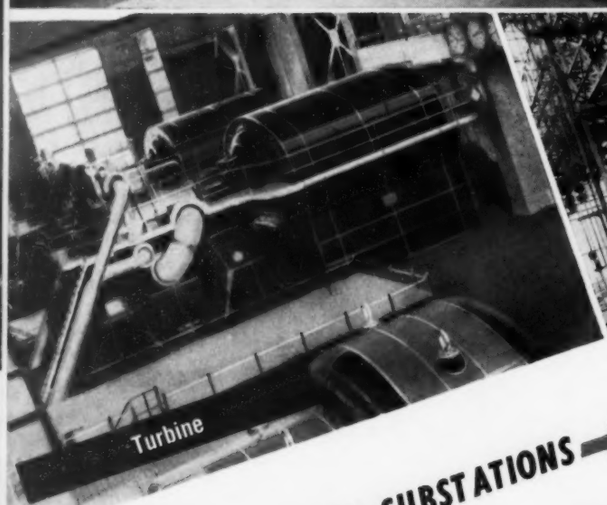
PENNSYLVANIA

MATHEWS CONVEYERS FOR MECHANIZED PRODUCTION

EVERY INSTALLATION RECOMMENDS Make your next mill G-E all from slab to finished

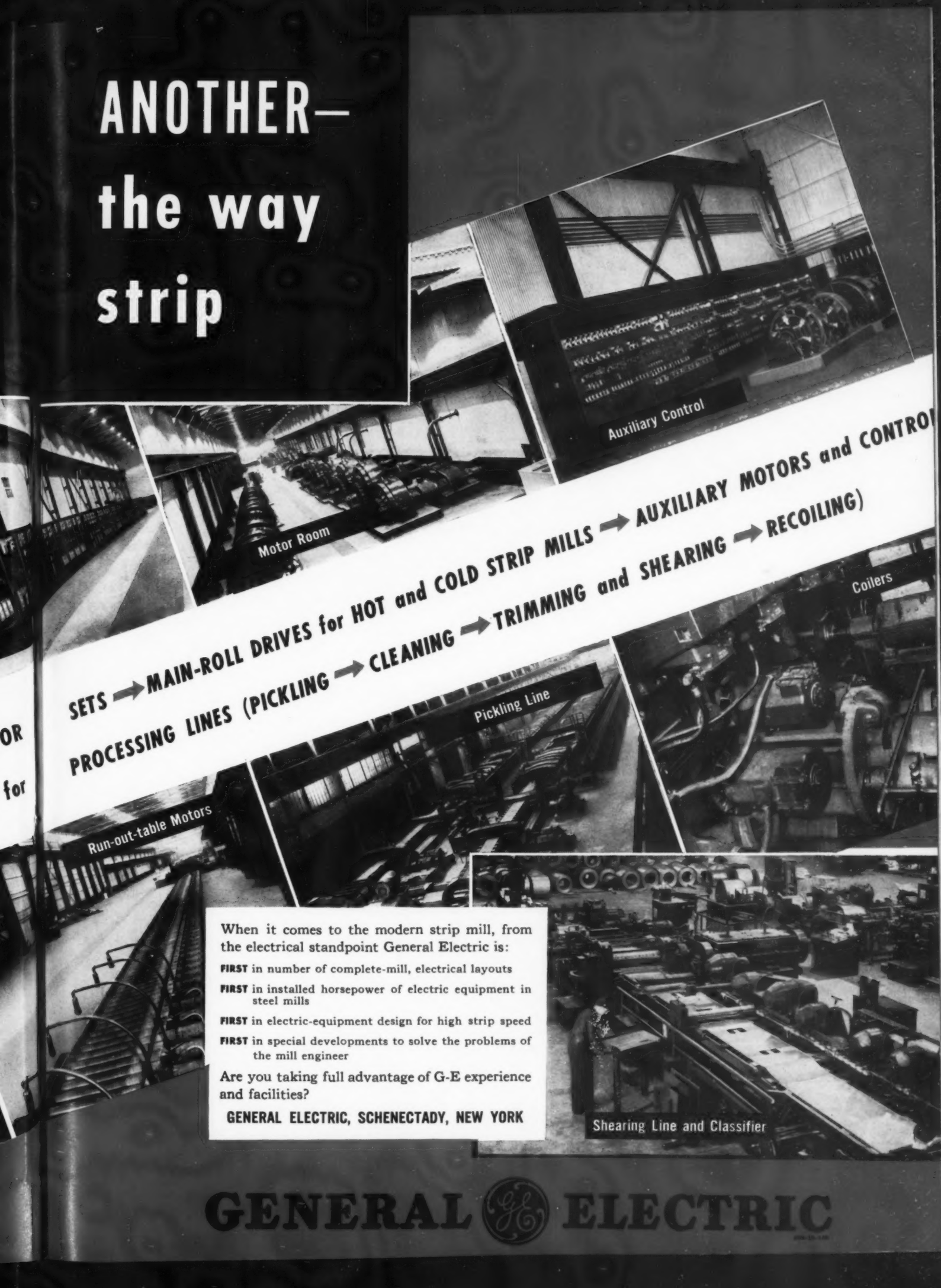






TURBINES → OUTDOOR SUBSTATIONS → TRANSFORMERS → SWITCHGEAR → MOTOR-GENERATOR
GENERAL-PURPOSE MOTORS and CONTROL → ANNEALING EQUIPMENT → EQUIPMENT for

ANOTHER— the way strip


Auxiliary Control
Motor Room
SETS → MAIN-ROLL DRIVES for HOT and COLD STRIP MILLS → AUXILIARY MOTORS and CONTRO
PROCESSING LINES (PICKLING → CLEANING → TRIMMING and SHEARING → RECOILING)
Coilers
Pickling Line
Run-out-table Motors
Shearing Line and Classifier

When it comes to the modern strip mill, from the electrical standpoint General Electric is:

FIRST in number of complete-mill, electrical layouts

FIRST in installed horsepower of electric equipment in steel mills

FIRST in electric-equipment design for high strip speed

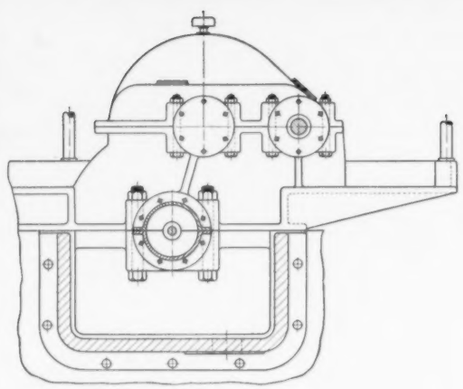
FIRST in special developments to solve the problems of the mill engineer

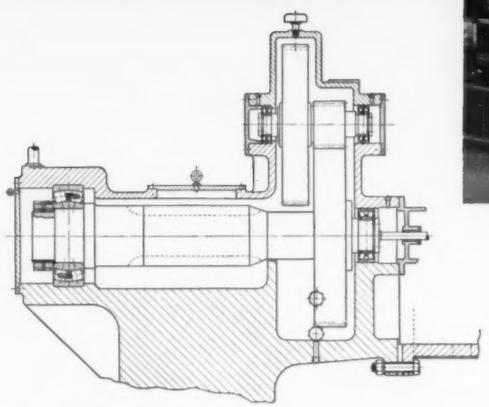
Are you taking full advantage of G-E experience and facilities?

GENERAL ELECTRIC, SCHENECTADY, NEW YORK

GENERAL ELECTRIC

HIGH THRUST CAPACITY
SELF-ALIGNMENT
are on the Screwdowns





HIGH thrust loads are imposed by these screwdowns on SKF Spherical Roller Bearings. They run over a hundred thousand pounds, but SKF's have been taking them for years. You see, the rolling alignment of SKF Bearings gives *high capacity* for overloads without binding . . . insures *accurate alignment.* Furthermore, SKF's are *practical* because their O.D.'s are relatively smaller than other types that might be used.

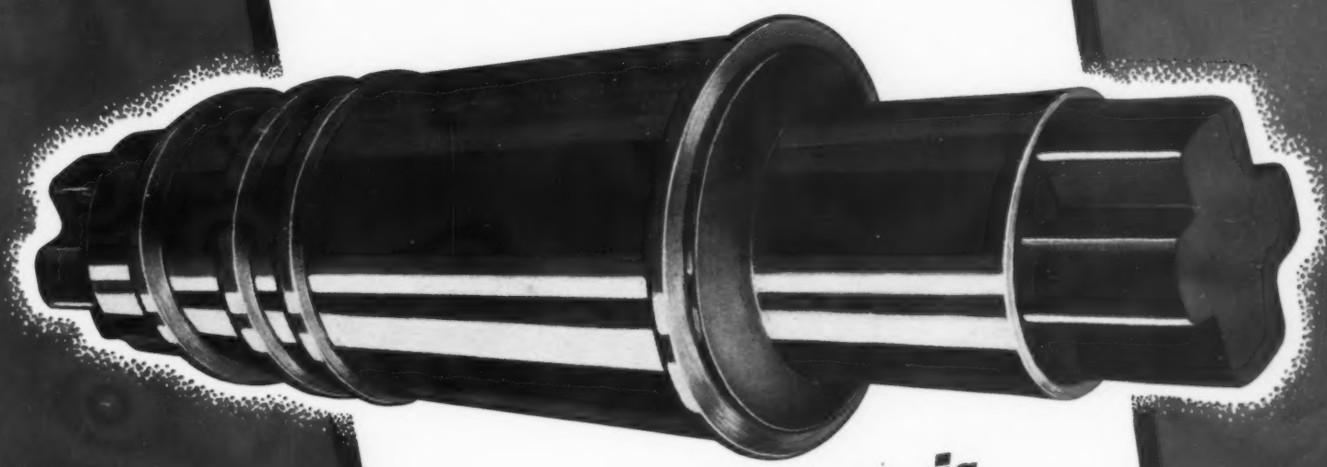
That means something where Production is the yardstick by which a machine is measured. SKF Industries, Inc., Front St. & Erie Ave., Philadelphia, Pa.

5024

BALL BEARINGS **SKF** ROLLER BEARINGS

when your problem is...

Higher Tonnage, Greater Toughness, Less Firecracking, Less Reduction Per Dressing, and Added Roll Strength for Blooming and Roughing . . .



the Answer is COPPER-ALLOY STEEL

Builders of:
Hydraulic Presses
Steel Mill Equipment Rolls
Special Machinery
Crushing Machinery

40 BIRDSBORO ROLLS
PAT. APP. FOR

BIRDSBORO STEEL FOUNDRY AND MACHINE CO. Plants at Birdsboro and Reading, Pa.

BIRDSBORO

ROLLS

Now 4 cuts in 2 min. 42 sec.

. . . INSTEAD OF 3 MIN. 45 SEC.

USING THE NEW Airco "45"

HIGH SPEED MACHINE CUTTING TIP

At this plant, an Airco Travograph is flame cutting four identical shapes, 77″ in periphery, from 5/16″ steel plate in 2 min. 42 sec. — with the new Airco "45" High Speed Machine Cutting Tips.

1 min. 3 sec. — this is the saving in time now made possible by the Airco "45" in this multiple cutting operation, which until recently required 3 min. 45 sec. with conventional tips.

Airco "45" was developed to bring you maximum cutting speeds — at a time when speed became essential to the country's war efforts. It increases the speed of machine gas cutting by 20 to 30% — without sacrifice in the quality of the cut *and with no increase in oxygen consumption.*

If your plant is engaged in war production and utilizes Airco oxyacetylene machines for cutting steel up to 8″ thick, we urge you to ask your nearest Airco office for further details or to request our 8-page bulletin on Airco "45".

Air Reduction

General Offices: **60 EAST 42nd ST., NEW YORK, N. Y.**

IN TEXAS
MAGNOLIA-AIRCO GAS PRODUCTS CO.
General Offices: **HOUSTON, TEXAS**
OFFICES IN ALL PRINCIPAL CITIES

AIRCO — WILSON

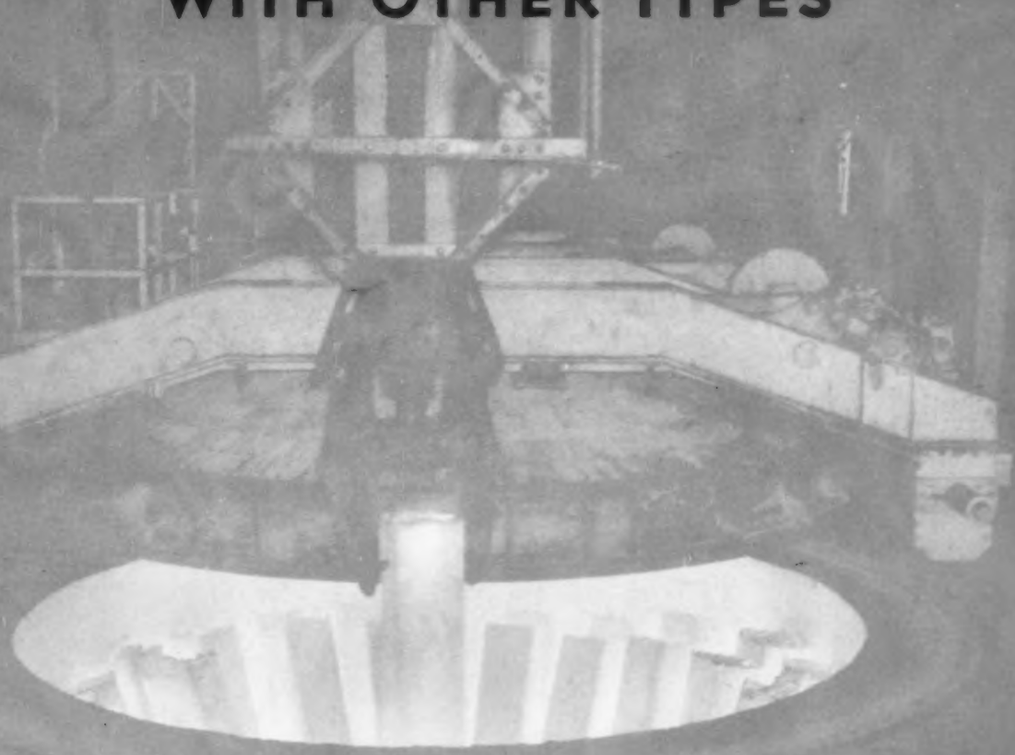
Anything and Everything for **GAS WELDING or CUTTING and ARC WELDING**

For all-out war production

COMPARE ..

SALEM CIRCULAR PITS

WITH OTHER TYPES



INGOTS HEATED IN SALEM CIRCULAR PITS ARE MORE UNIFORM AND——

Require 4 hours LESS heating time for cold steel
Require 3 LESS passes through the mill
Require LESS power on the mill
Require LESS conditioning
Have LESS scale formation (single jacket) and increases production 25% for the same space

SALEM ENGINEERING COMPANY

SALEM ENGINEERING CO., SALEM, OHIO

"I'VE LEARNED SOMETHING NEW ABOUT CRANE DELIVERIES"

"We're used to delays these days. So when P&H promised a definite delivery date I said, 'Well, maybe!' But when that day came, here was our crane — right on time.

"We've learned that there's a real advantage in P&H's more advanced crane-building facilities. We've seen what P&H can do when given full control of crane production, including such items as electrical apparatus, etc. And we've learned something about greater crane values per dollar of cost."

P&H is America's largest and only crane builder producing complete electrical equipment.

Gen. Off.: 4455 W. National Ave., Milwaukee, Wis.

HARNISCHFEGER
CORPORATION
ELECTRIC CRANES • EXCAVATORS • ARC WELDERS P&H HOISTS • WELDING ELECTRODES • MOTORS

P&H
OVERHEAD CRANES

EASY ON THE CRANE ...easy on the Operator!

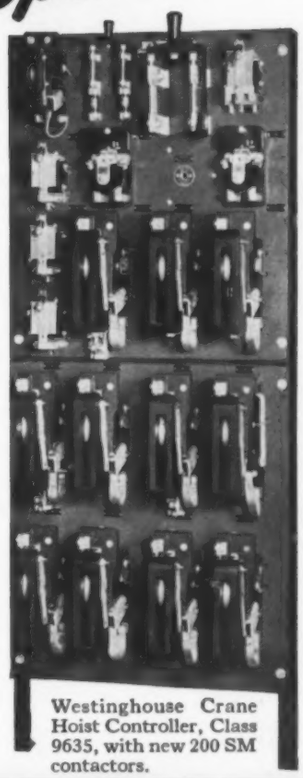
Graduated dynamic braking and accurate inching control makes crane operation easier . . . safer!

Here's control that speeds up hoisting operations—yet reduces stress and strain on both crane and operator!

Faster light-hook lowering speed saves time between loads, yet without excessive speeds when lowering heavy loads—and without complications and hazards of load relays. At the same time, graduated dynamic braking, which accomplishes most of the deceleration before the magnetic brake sets, reduces stresses on the crane and gives smoother braking action.

Inching control is made more accurate—load handling is made easier, quicker, safer. Write today for bulletin DD-9600 containing full details. Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa., Dept. 7-N.

J-21149



Westinghouse Crane Hoist Controller, Class 9635, with new 200 SM contactors.

Westinghouse D. C. CRANE CONTROLLERS

W WESTINGHOUSE ELECTRIC

LEWIS

Up and Down cut SHEAR

LEAVES THE SLAB STRAIGHT AND TRUE AFTER CROPPING

This new 1350-ton Lewis Heavy Duty Cold Slab Shear is saving time on the Victory Program.

LEADING FEATURES

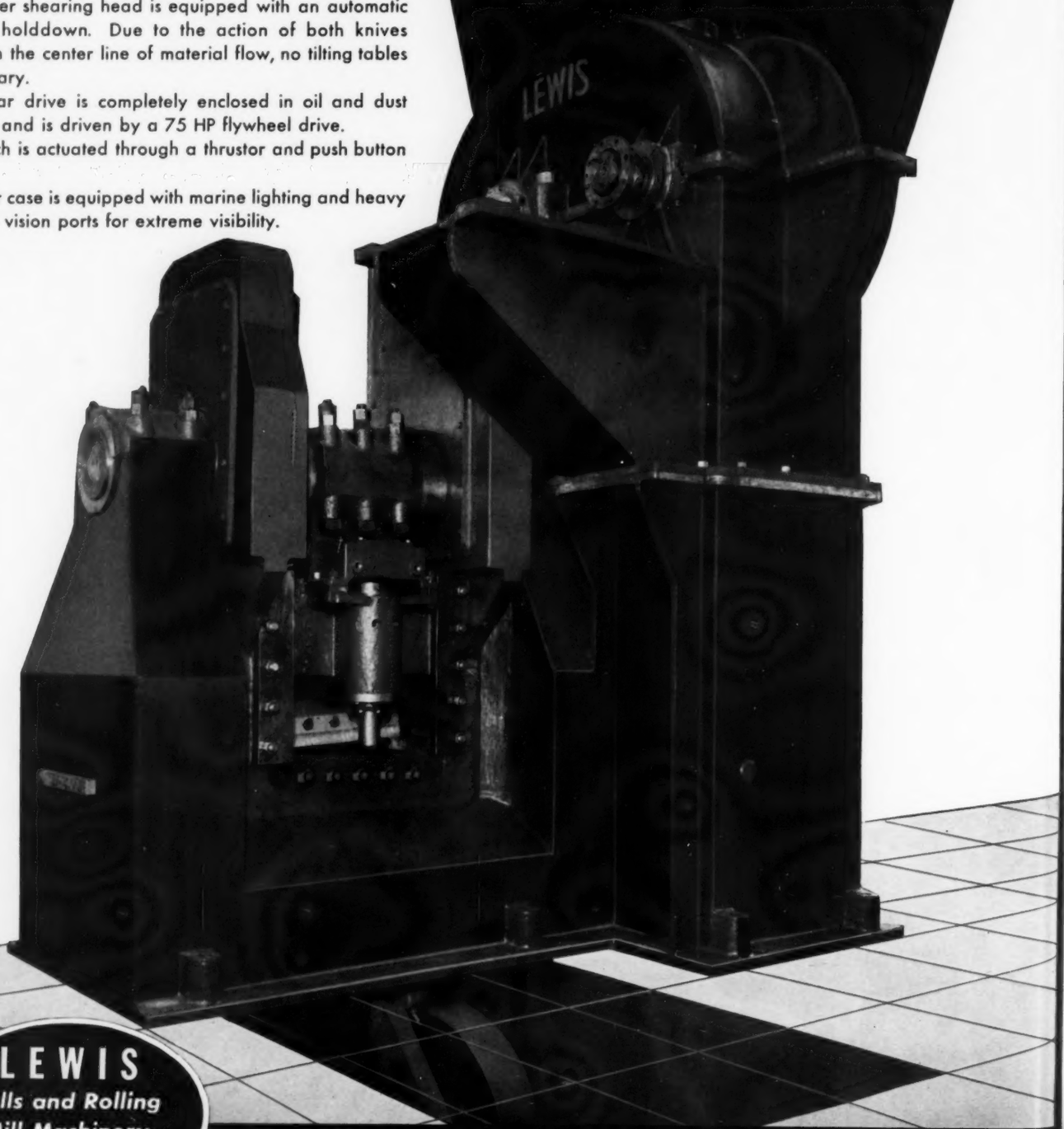
This shear is designed to crop 3" x 25" slabs. Both upper and lower knives function in vertical slides eliminating oscillation of the main cutting frame and assuring a true cut and straight slab after cropping.

The upper shearing head is equipped with an automatic hydraulic holddown. Due to the action of both knives meeting on the center line of material flow, no tilting tables are necessary.

The shear drive is completely enclosed in oil and dust tight cases and is driven by a 75 HP flywheel drive.

The clutch is actuated through a thrustor and push button control.

The gear case is equipped with marine lighting and heavy plate glass vision ports for extreme visibility.



LEWIS
Rolls and Rolling Mill Machinery step up tonnage

LEWIS FOUNDRY & MACHINE
DIVISION OF BLAW-KNOX CO.
PITTSBURGH, PA.

4976

Smooth Running of DE LAVAL EXHAUSTERS pleases plant operators

THE three De Laval turbine driven exhausters here shown are highly praised by the personnel responsible for their operation and maintenance.

They draw gas from holders in which it is received from water gas generators and force the gas through condensers, scrubbers and purifiers, light oil scrubbers and meters to storage holders, where it is mixed with natural gas from pipe lines.

The units are rated to deliver 2280 to 5700 cu. ft. per min. each, with a maximum pressure differential of 60 ins. water column. In order to provide the wide variation in capacities and pressures, the operator can at any time, by the simple adjustment of a needle valve, set the variable speed hydraulic governors on the turbines for the speed desired.

The rugged cast iron construction of the blower casing insures good alignment and quiet operation in spite of sudden changes in delivery. Both the turbine casing and blower casing are split horizontally, providing complete accessibility.

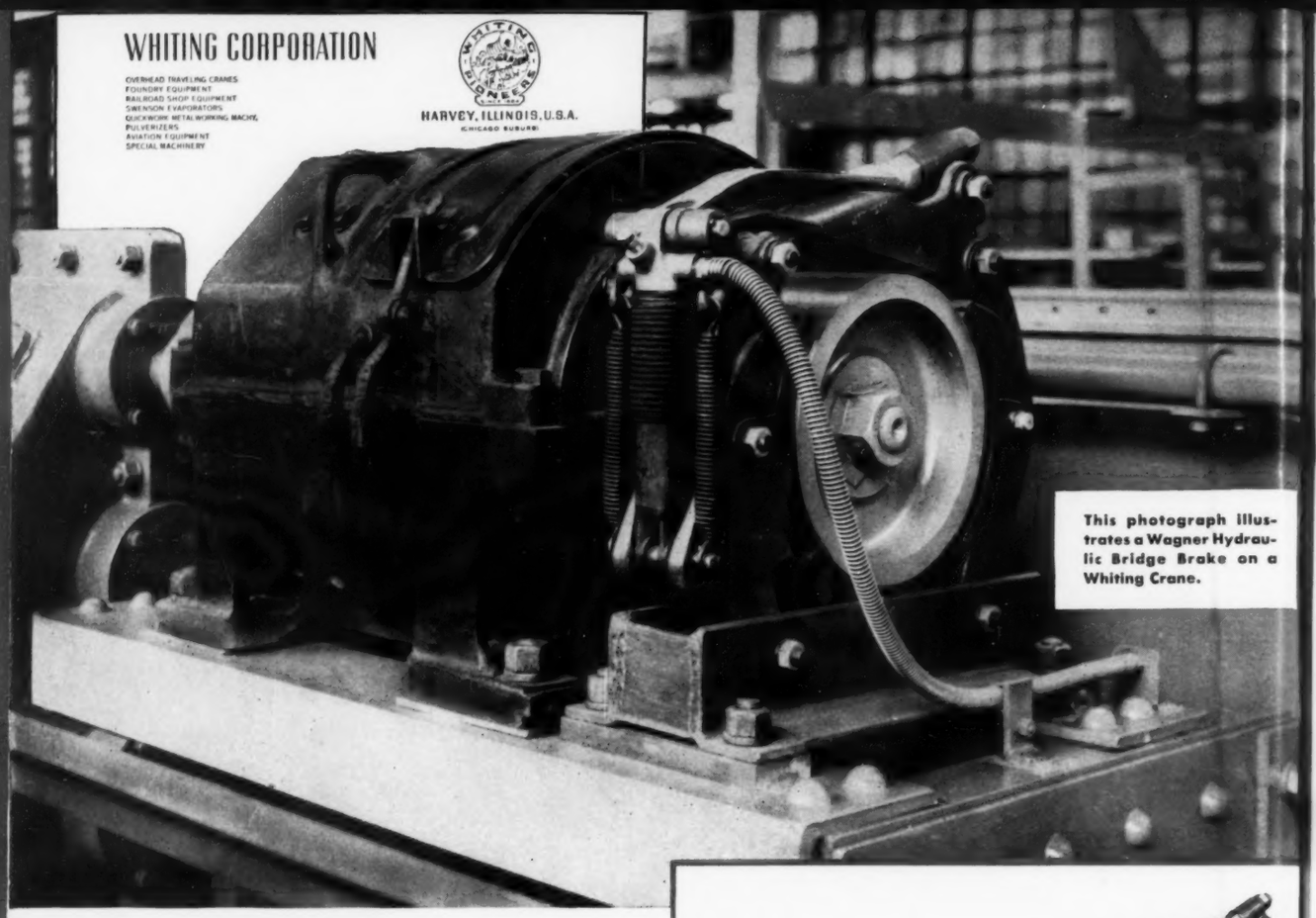
The turbine and the blower each has its separate shaft and bearings, the two shafts being connected by a lubricated, all-metal, flexible coupling. This four bearing construction is more rugged and smoother running than is the overhung type of turbine blower unit with only one shaft and two bearings for the two members, as it is less likely to be unstable and to whip when slight unbalancing or wear occurs.

If you use blowers or compressors you will be interested in the wealth of data contained in our new Compressor Catalog F-3819.

DE LAVAL *Steam Turbine Co.*
TRENTON, N. J.

MANUFACTURERS OF TURBINES . . . STEAM, HYDRAULIC; PUMPS . . . CENTRIFUGAL, PROPELLER, ROTARY DISPLACEMENT, MOTOR-MOUNTED, MIXED-FLOW, CLOGLESS, SELF-PRIMING; CENTRIFUGAL BLOWERS and COMPRESSORS; GEARS . . . WORM, HELICAL, and FLEXIBLE COUPLINGS

ANOTHER CRANE MANUFACTURER USES **WAGNER** HYDRAULIC BRIDGE BRAKES



This photograph illustrates a Wagner Hydraulic Bridge Brake on a Whiting Crane.

WAGNER HYDRAULIC BRIDGE BRAKES Are The First Choice of Crane Manufacturers

Whiting Corporation, like many crane manufacturers, uses Wagner Hydraulic Bridge Brakes on their cranes because they have found through actual experience that Wagner Hydraulic Bridge Brakes perform satisfactorily under even the most severe operating conditions.

Wagner Hydraulic Bridge Brakes assure positive braking action and smooth acceleration. They have a high safety factor and assure crane users of the highest braking efficiency. A few of the many outstanding features are: **1.** Easy one-point adjustment... **2.** Exclusive anti-drag device... **3.** They have hardened pins, knurled to prevent rotation... **4.** They have bushings at points of maximum wear... **5.** Grease fittings are provided on all hinge pins... **6.** The friction blocks are extra thick and bolted to the shoes... **7.** They are built by a manufacturer of Lockheed hydraulic brakes... **8.** Wagner provides nation-wide service through twenty-five branches.

3 This is the third of a series of advertisements designed to acquaint crane users with a few of the many crane manufacturers who are now equipping their cranes with Wagner Hydraulic Bridge Brakes.

TYPE H

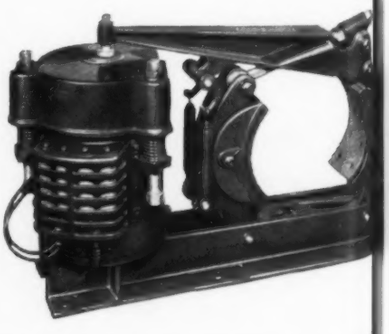
For Inside Cranes

Wagner hydraulically actuated bridge brake for normal service stops.

TYPE HM

For Outside Cranes

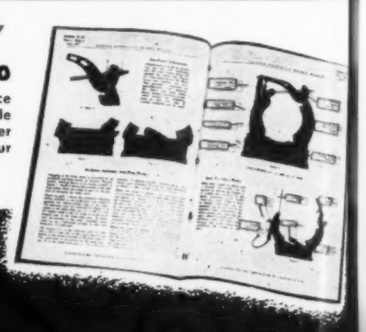
Wagner hydraulically actuated bridge brake with automatic parking attachment.



SEND TODAY

FOR BULLETIN IU-20

Every production, safety, and maintenance superintendent should have this valuable bulletin. It completely describes Wagner Hydraulic Bridge Brakes. Write for your FREE copy today.



Wagner Electric Corporation

6400 Plymouth Avenue, Saint Louis, Mo., U.S.A.

BRAKES · MOTORS · TRANSFORMERS · FANS

WHEN you can swap 1000 tons of billets for 1000 tons of finished shapes, you will be doing everything possible to conserve material.

Morgan Mills are approaching this ideal. After all, it's simply a matter of detail: proper design, ease of control, careful installation, etc. And these qualities have been synonymous with Morgan for half a century.

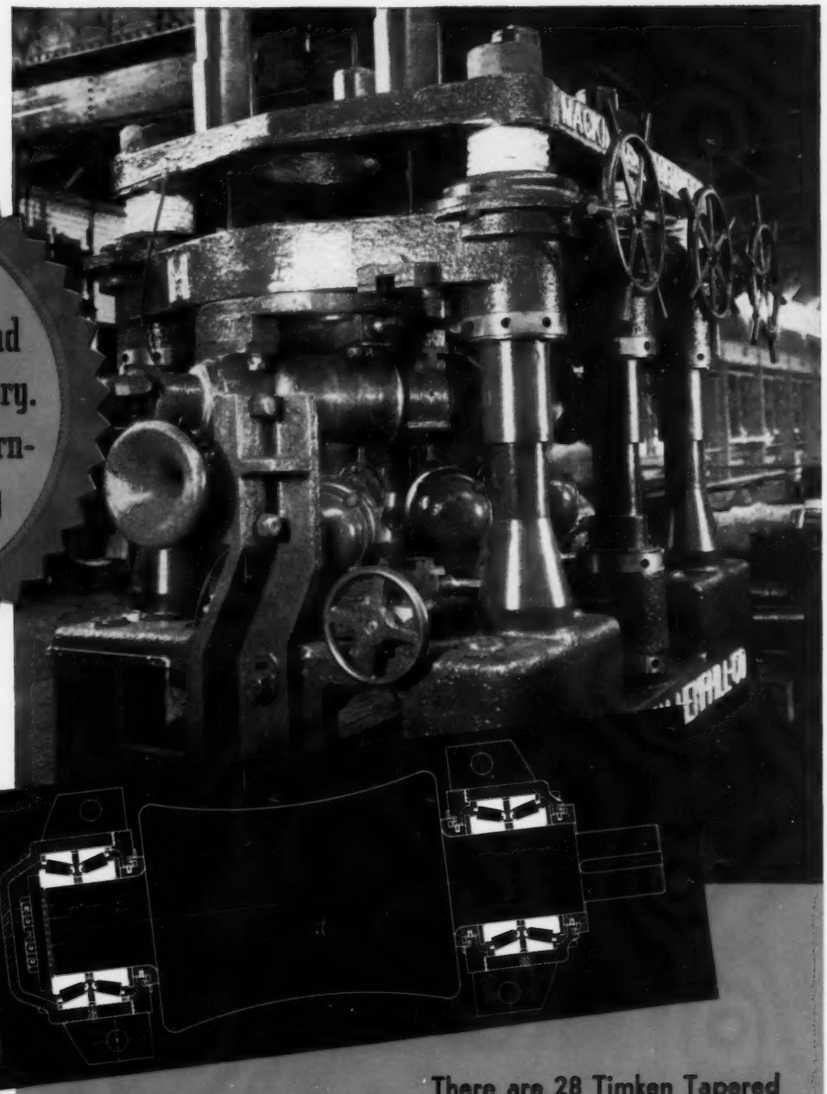
May we be of assistance?

MORGAN
WORCESTER
ENGINEERS AND
MANUFACTURERS

MORGAN CONSTRUCTION COMPANY • WORCESTER, MASSACHUSETTS

R-98

Timken Bearings are keeping wheels and shafts turning for Victory. They'll keep them turning for prosperity afterwards.



Application of Timken Bearings to the roll necks of the above bar straightener.

There are 28 Timken Tapered Roller Bearings on guard against friction, radial loads, thrust loads and misalignment in this Mackintosh-Hemphill Bar Straightener—12 on the roll necks, 16 in the drives.

This machine is designed to handle 6" diameter solids and 9½" diameter tubes, which gives some idea of the loads imposed on the bearings. It is in operation at a Canadian armament plant.

There is hardly any kind of equipment used in the steel industry that does not embody the speed, accuracy, dependability and endurance of Timken Roller Bearings. These machines—many of them redesigned to include a full complement of Timken Bearings—will greatly assist economic rehabilitation in the years to come.

THE TIMKEN ROLLER BEARING COMPANY, CANTON, OHIO

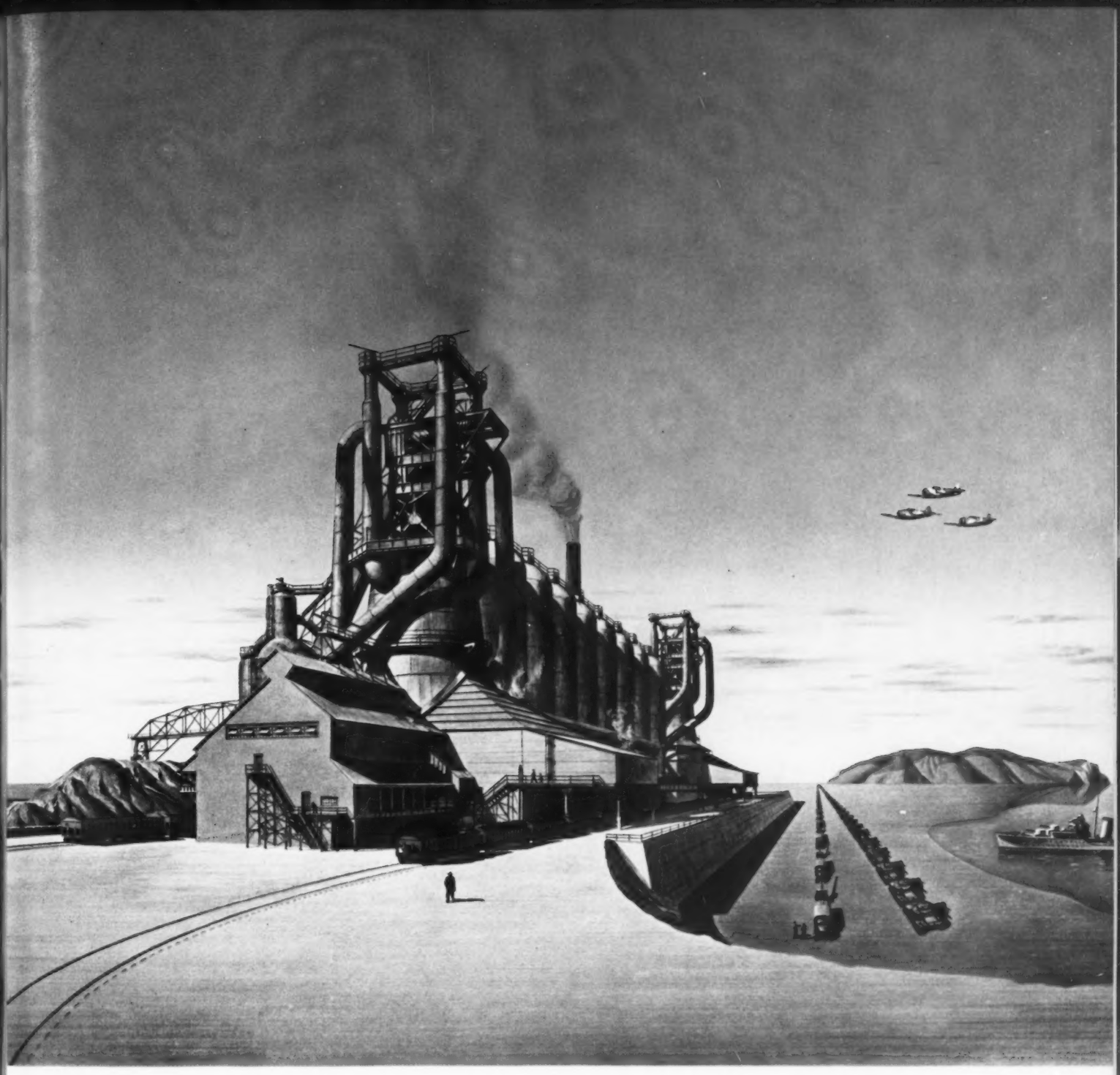
TO ASSURE VICTORY BUY UNITED STATES DEFENSE BONDS & STAMPS

TIMKEN

TRADE-MARK REG. U. S. PAT. OFF.

TAPERED ROLLER BEARINGS

Manufacturers of Timken Tapered Roller Bearings for automobiles, motor trucks, railroad cars and locomotives and all kinds of industrial machinery; Timken Alloy Steels and Carbon and Alloy Seamless Tubing; and Timken Rock Bits.



Steel Is More Precious Than Gold

At the most critical moment in our history, we bury our gold in some mid-western field, and work frantically to produce more and more of the steel which is far more precious to us *now*, than gold.

This is a *steel* war. The greatest hope of mankind is the fact that America alone can produce 50% *more* steel than all the Axis-dominated countries.

The process of steel-making starts at the blast furnace, and a blast furnace needs enormous quantities of coke. Censorship forbids us to tell how greatly coke production has been increased with new Koppers coke ovens, but it is a heart-warming figure.

These ovens convert millions of tons of coal into coke, gas and other products, vast quantities of which are further processed by Koppers into chemicals used in the explosives, plastics, synthetics, rubber, dyes and drugs now so important to military success.

Among the many products Koppers has furnished for years to the steel industry are Fast's self-aligning couplings; special D-H-S Bronze for gears, slippers, segments, housing nuts, and bearings; iron gate valves; pressure-treated ties and timber; roofing, waterproofing and road materials; piston rings; deodorants and disinfectants.

These products help make it possible to produce ever-increasing quantities of steel for tanks, guns, planes, ships and munitions. *It's up to American Industry.* Koppers Company, Pittsburgh, Pa.

KOPPERS

THE INDUSTRY THAT SERVES ALL INDUSTRY

BUY UNITED STATES DEFENSE BONDS AND STAMPS

WAR

The first outstanding feature you will note after you have purchased a Cleveland all-welded Crane is the ease and speed with which it is erected.

If it is of a type and size you would expect to require from 10 days to two weeks to erect, you will be surprised to see the Cleveland up and in operation in 5 to 6 days. If it's a large heavy-duty Crane with considerable electrical equipment that you know from experience ordinarily takes two to three weeks to install, you will be amazed to see the Cleveland complete and running in a week to 10 days.

The figures quoted are not exceptional but usual with Cleveland all-welded Cranes. They have been proved time and again on many large jobs where various makes of cranes have been installed at approximately the same time.

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FOR ALL PACKED TOWER PROCESSES

. . SUCH AS DEHYDRATION OF AIR AND THE RECOVERY OF HYDROGEN SULPHIDE

Use NATIONAL TRADE-MARK *Carbon Raschig Rings*

ADVANTAGES OF RASCHIG RINGS

1. Large surface exposure per unit of volume gives high reaction efficiency.
2. Large free cross section minimizes internal friction and gas velocity.
3. Large free volume allows time for complete absorption.

FURTHER ADVANTAGES OF CARBON RASCHIG RINGS

1. High resistance to the destructive action of corrosive materials, such as sulphides and hot alkaline solutions, assures long life.
2. High resistance to thermal shock reduces spalling and breakage.
3. Low weight per unit volume reduces cost of tower construction.

PLAIN CARBON RASCHIG RINGS ARE MADE IN 8 SIZES:

$\frac{1}{4}''$, $\frac{1}{2}''$, $\frac{3}{4}''$, $1''$
$1\frac{1}{4}''$, $1\frac{1}{2}''$, $2''$, $3''$

1-inch Splined Rings and 1-inch Lessing Rings are also available. These provide about 25 per cent more absorption surface than 1-inch plain rings.

OTHER CARBON, GRAPHITE AND "KARBATE" PRODUCTS USED IN THE IRON AND STEEL INDUSTRY

★ Mold plugs, cores, inserts, small molds and crucibles.

★ Brick and slabs for lining troughs and acid processing equipment.

★ Rolls and bearings for continuous strip pickling tanks.

★ Pipe, valves and fittings for heating pickling solutions and for other uses in contact with corrosive materials.

"Karbate" products are carbon or graphite materials made impervious to seepage of liquids or gases under pressure.

"NATIONAL" CARBON, GRAPHITE AND "KARBATE" PRODUCTS ARE EFFECTING SUBSTANTIAL ECONOMIES IN STEEL PLANT OPERATION AND MAINTENANCE

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The words "National" and "Karbate" are trade-marks of National Carbon Company, Inc.

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DESIGNED
TO WORK TOGETHER
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WHEN ORDERING FROM YOUR **FURNACE BUILDER** INSIST ON NORTH AMERICAN COMBUSTION EQUIPMENT.
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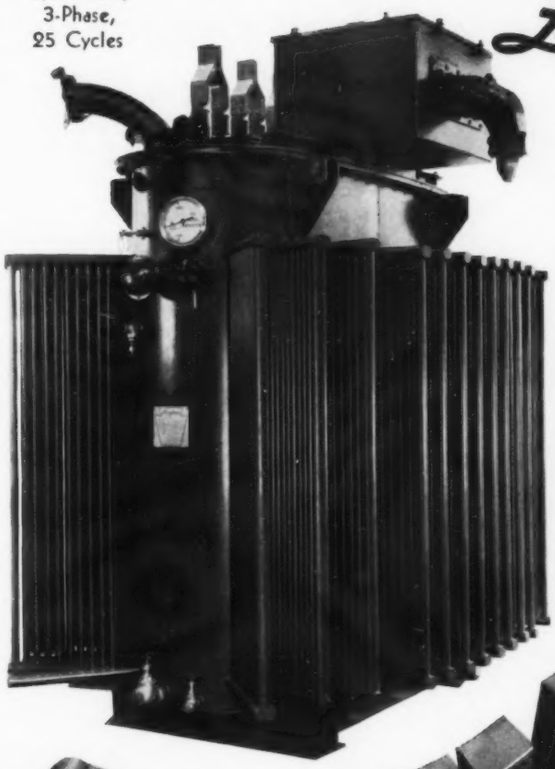
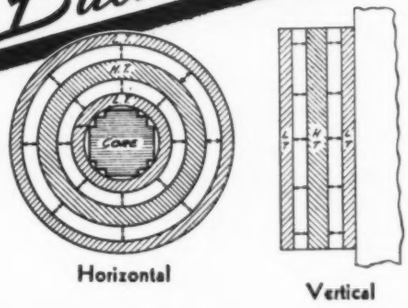


Pennsylvania ASKAREL non-inflammable TRANSFORMERS

Like all Pennsylvania Transformers, ASKAREL Transformers are equipped with Circular Coils. In non-inflammable transformers there are many fundamental reasons why. . .

CIRCULAR COILS ...make the big difference

Balanced



The circular coil is practically balanced, radially and axially, against short circuit stresses.

When a transformer is subjected to heavy overload or short circuit, the circular coil maintains its shape even without the use of compound or varnish. By eliminating such stresses, the coil is not strained, and the insulation is not injured.

In regular oil cooled transformers, varnish is used to increase the mechanical and electrical strength of the transformer coils, irrespective of the shape of the coils. This kind of varnish, however, cannot be used to treat coils in a transformer where non-inflammable liquids are employed. Therefore, without the aid of this varnish, it is imperative that the coils in a non-inflammable transformer have *great inherent strength.*

CIRCULAR COILS POSSESS THE MAXIMUM INHERENT MECHANICAL AND ELECTRICAL STRENGTH.

1. In a circular coil the tension of each turn of wire is uniform throughout its length. No coil of any other shape possesses this quality.
2. The turns in a circular coil are wound tightly without excessive tension on the wire — thus eliminating the possibility of stretching the wire and injuring the insulation.

Pennsylvania *ASKAREL* Transformers offer you the convenience and economy of indoor installations near the load centers, plus the added safety inherent in the Pennsylvania circular coil construction.

Pennsylvania TRANSFORMER COMPANY
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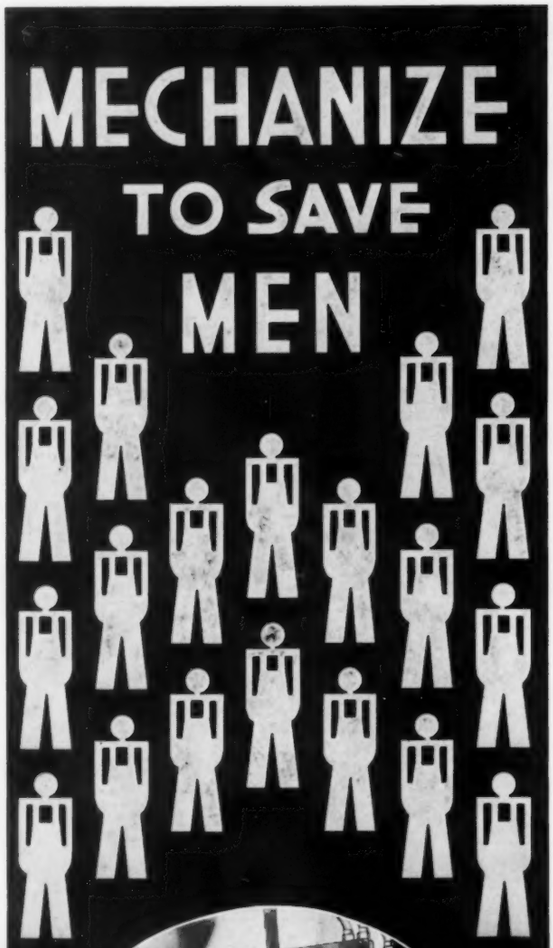


10 to 20 Hand Chippers Can be Transferred to More Productive Work

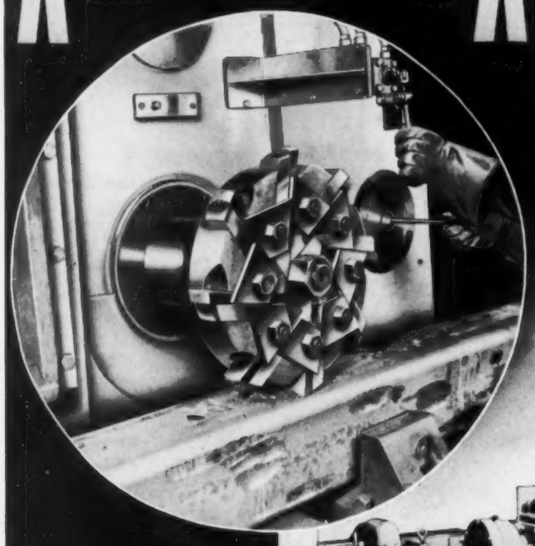
Wouldn't you say that using ten to twenty men on a job that can be done by ONE man is a waste of man-power?

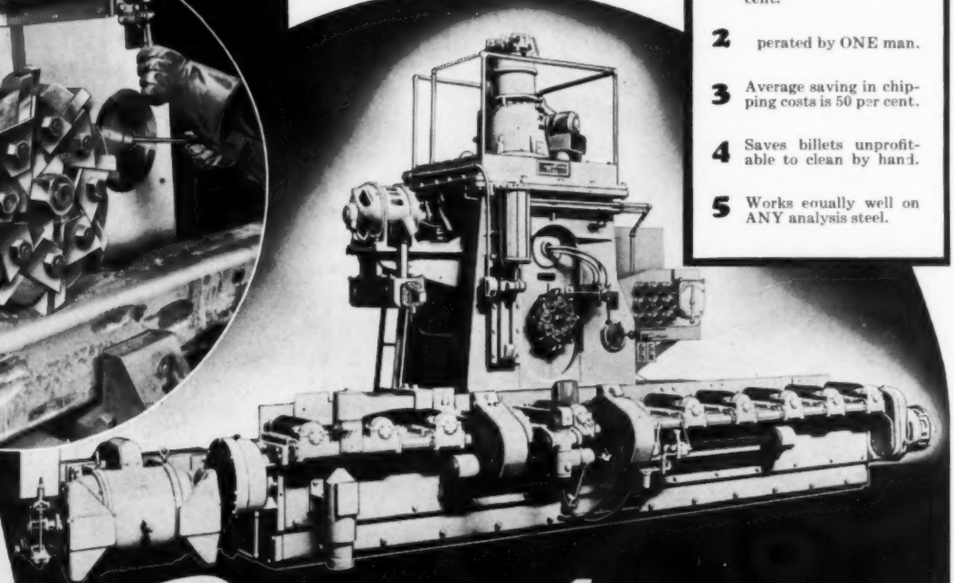
Yet Victory efforts are being handicapped today, in many instances, by conditioning heavy tonnages of billets with slow, out-dated hand methods, which at best require ten times more man-hours than when using

BILLETEERS

The Billeteer is built for action! Every operation is accurately controlled from the instant the operator presses the button that rolls a billet off the feed skids onto the machine, to the final movement of the thoroughly cleaned billet over the discharge table.

The demand for Billeteers outstrips our production facilities — which is all the more reason you should talk with one of our sales engineers **without delay.** Very high priority rating is given this equipment.





FACTS

1. Speeds up billet chipping as much as 90 per cent.
2. perated by ONE man.
3. Average saving in chipping costs is 50 per cent.
4. Saves billets unprofitable to clean by hand.
5. Works equally well on ANY analysis steel.

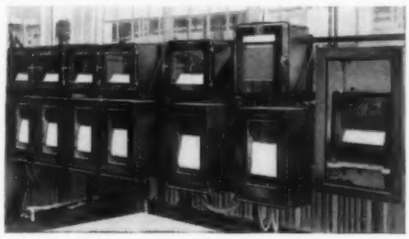
BUILDERS OF BONNOT-LENTZ BILLETEERS ALSO CRUSHING PULVERIZING AND MIXING EQUIPMENT

THE Bonnot COMPANY
STEEL EQUIPMENT DIVISION
CANTON, OHIO

Micromax Pyrometers Are Centralized At Rock Island

Practically all heat-treating processes in the Rock Island Arsenal are provided with the latest type of automatic control, no expense having been spared to assure a close check on heat-treating operations. There are appproximately fifty Micromax potentiometer controls, supplied by the Leeds & Northrup

Above: Some of the Micromax Pyrometers controlling Rock Island's heat-treats.
Below: A battery of older L&N Controlling Pyrometers still working dependably and accurately.



Company. Armor plate and forging furnaces are equipped with a Micromax Rayotube and a Micromax electric proportioning control, and there is a large stress-relieving furnace in the Welding Shop which is supplied with a Micromax electric proportioning control.

Reprinted from "Machinery"

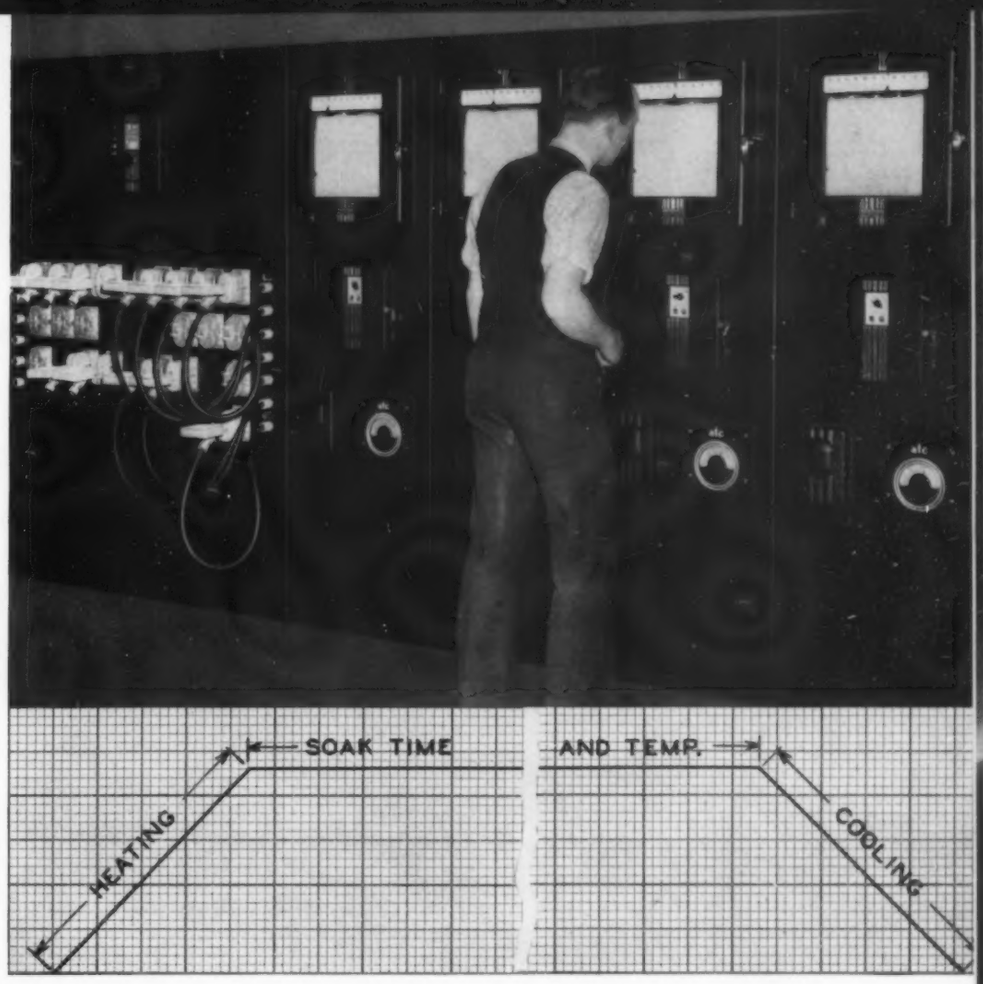
Thanks, "Anon"

To the several hundred men, most of them anonymous, who recently helped us with a questionnaire, we take this way of expressing our sincere thanks. These gentlemen received cards which they were asked to fill in and return unsigned, ballot-wise, regarding one of our advertising messages, and we're very grateful for their help.

We asked nothing about the merits of L&N products, and for that reason especially appreciate the correspondents who went far out of their way to give us a back-pat. "One of the greatest wonders in the steel mill today is L&N instruments" says one user. And one of the biggest furnace manufacturers says "Don't know how you could improve on (Micromax) instruments—they are 'tops'."

"All our instrument men" keynotes one good friend "believe L&N are the best pyrometers." And another says "I like your instruments because you make them so easy for glance reading." And so on, far beyond the limits of the space at our disposal.

Thanks again, friends.



Program Control Panel of Micromax Pyrometers. It regulates the annealing, in Wilson cover furnaces, of steel strip and wire for such things as cartridge clips, rifle springs, mask parts and quantities of other defense items. In starting a batch, a controller first uses on-off valve motion, in response to temperature of furnace tube; then it shifts to throttling (proportional position and floating) control, based on work temperature. The rate of heating, the rate of cooling, and the time of soaking, are automatically held as set, unless user switches off these features.

WANT TO "BEND" A TEMPERATURE For Better Heating of War's Matériel?

Program Control is one of the newer ideas now drafted by war industries to help secure the fast, accurate, automatic heat-treatment required by so much war matériel.

Program Control is an improvement over the usual control, which considers only the maximum or soak temperature; because Program Control regulates the rates of heating and cooling, as well as the maximum. The record on the pyrometer chart rises at any desired rate, "bends" at the desired soak temperature, holds the soak as long as is specified, and then "bends" down again into a controlled cooling cycle, to complete the program which will best fit the product for war's needs.

In this strenuous "temperature-bending", various Micromax characteristics are important, but possibly the most useful one is its "micro"-responsiveness. Micromax acts with superior speed-plus-precision on the *small* fluctuations of temperature. Even before these fluctuations are big enough to show on the chart—therefore, even before the best furnace operator could act—the Micromax acts. This micro-responsive handling of tiny changes heads off the big swings—throttles them so that they never develop. Micromax holds temperature with the steadiness needed for uniformity of product.

Micromax Program Control uses standard instruments, grouped at our plant to meet the individual need. If you have a problem along such lines, we'll be glad to try to help in its solution.

Jrl Ad ENT-0600C(44)

LEEDS & NORTHRUP COMPANY, 4942 STENTON AVE., PHILA., PA.

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MEASURING INSTRUMENTS · TELEMETERS · AUTOMATIC CONTROLS · HEAT-TREATING FURNACES

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Non-Metallic RYERTEX BEARINGS

A complete saving of scarce wartime metals—Ryertex Bearings are a resin-fabric compound molded to your requirements.

Water-Lubricated RYERTEX BEARINGS

They consume less power per operation and last many times longer than metallic bearings, may be lubricated with water, oils or grease if desired.

Precision-Built RYERTEX BEARINGS

Easy to install and maintain . . . the exact design of Ryertex Bearings gives them longer life and permits rolling to closer tolerances which cuts down scrap losses.

● Whether your bearing problems involve roll necks, spindle carriers or roller twist guides — you'll save with RYERTEX. Our experts are ready to help you take advantage of the bearing experience of many different types of mills. Get in touch with your nearest Ryerson Plant today. Joseph T. Ryerson & Son, Inc., Chicago, Milwaukee, St. Louis, Cincinnati, Detroit, Cleveland, Buffalo, Boston, Philadelphia, Jersey City.

Convention Plans for 1942

The Association of Iron and Steel Engineers announces that its 1942 Annual Convention, to be held in Pittsburgh, September 22, 23 and 24, will follow the lines of an engineering conference, with particular emphasis on the steel industry's problems in the current crisis. The technical program will be amplified and will give broader coverage of the present needs of steel plant engineers. Free interchange of ideas upon the timely topics of vital interest going to make up this program will aid in the successful conclusion of our production drive for victory.

The Iron and Steel Exposition, usually held in conjunction with the Convention, has been suspended for this year. This step was prompted by the critical times, in the belief that equipment and material going to make up the exhibits should not be delayed in taking its place in the production front.

SCARFING

High Carbon and Alloy Steels

*By G. D. Winlack**

Steel Mill Engineer

AIR REDUCTION SALES CO.

New York, N. Y.

Presented before

A.I.S.E. ANNUAL CONVENTION

G. D. WINLACK

▲ ALTHOUGH torch deseaming, or "scarfing," was first adopted by some of the leading steel comgnies twelve to fifteen years ago, it has been only in the last few years that its great value to the industry has been fully recognized by practically all steel producers. Partially responsible for this recognition has been the constantly increasing demand for superior steel products produced at higher speeds and lower costs. This demand is exemplified by the high quality steel required by the automotive and aircraft industries and the railroads, in which all surface defects of blooms, slabs and billets must be removed at whatever stage of production they appear. To meet these increasingly stringent requirements, a process must be employed that will do this work satisfactorily and with economy, yet not interfere with production schedules. All steel producers fully recognize that the older methods of cleaning steel by hand chipping, machine chipping or swing grinding, are not only exceedingly slow, when considering the tempo of the present day production units, but also very costly. The storage and re-handling of large stocks of unfinished steel is a great obstacle in the high speed production program of the mills today.

With the newest steel cleaning method, torch deseaming or scarfing, it is possible to maintain a smooth production flow without difficulty and at the same time to conserve space, eliminate much rehandling, lower the production cost and produce a satisfactory product.

Scarfing is a process of burning out defective areas on the surface of semi-finished steel, by the oxyacetylene method. By this means, the surface of the steel is placed in such a condition that it can be rolled or forged to a satisfactory product.

Use of the scarfing process has increased very rapidly during the past few years. Many plants are now scarfing 100 per cent of all their semi-finished products. In fact, the use of scarfing for removal of defects has increased to such an extent that the tonnage now cleaned by this method compares favorably with that of the combined tonnages now cleaned by hand chipping, machine chipping and swing grinding. Large savings in time with large economies are being realized by the plants using the oxyacetylene cleaning process. It is in most cases from 6 to 15 times faster than mechanical chipping, hand chipping or swing grinding.

The value of the scarfing process becomes even more apparent with the increase in the amount of surface cleaning required per ton of steel conditioned.

For a period after its introduction, the scarfing operation was only used as an auxiliary to hand chipping and on salvage or reclamation work for cleaning of badly cracked ingots, blooms, billets and slabs, which otherwise would be scrapped due to prohibitive cleaning costs. This is not so today. Development of deseaming techniques for the various grades of steel in their many sizes and sections, from ingots to 1½ in. square billets, along with many improvements in torches, tips and auxiliary starting equipment, has advanced to a point where today, scarfing is being done on practically all grades of steel which oxidize readily under an oxygen

* Mr. Winlack died in Cincinnati, Ohio, December 1941.

stream. Steels now being scarfed include all grades formerly chipped and a great number of grades formerly "swing ground." This includes practically every SAE grade of steel with the exception of the corrosion and heat resisting steels. Also, a great many special grades of alloy and tool steels not listed on the SAE steel classification, which are generally swing ground, can be and are being cleaned by the oxyacetylene process.

Metallurgy of Scarfing

The removal of defective surfaces from the higher carbon alloy and tool steels by scarfing involves some metallurgical factors, which, if not taken into consideration, will probably result in failure of the operation. The rapid heating of the steel surface by the oxyacetylene preheating flames and the heat of the oxygen-iron reaction will cause a change in the structure at the surface with resultant varying degrees of hardness and highly localized stresses. The hardness and stresses developed are governed by the analysis of the steel. The same properties are present in the scarfed surface as would be developed by a hardening treatment, since the quenching effect of the cold center on the hot surface of the steel is even more drastic than quenching in water. A hardened case is formed on the steel surface to approximately 0.15-.030 in. in depth, depending on the character and analysis of the steel.

It is well known that, when a marked change of hardness is present with accompanying high localized stresses in a piece of steel, there is great danger of cracking the piece. It can readily be understood that such a condition may be present in steel of high hardenability which has been scarfed unless adequate precautions are taken. Lack of consideration of this factor was largely responsible for a great deal of adverse criticism, which was directed against scarfing when the process was first used on alloy and high carbon steels. Since adequate precautions were not taken at first, a great deal of the material was scrapped due to cracking and the blame categorically fastened upon the scarfing operation.

If the above-mentioned quenching effect of the cold center of the steel could be rendered less drastic, the marked hardness gradient and high stresses in the steel after scarfing, could be materially reduced and the danger of cracking eliminated.

The obvious answer to this problem is preheating the steel before scarfing to cut down the temperature gradient between the scarfed surface and the center of the steel. The degree of preheating necessary is dependent upon the analysis of the steel and its resultant hardenability.

Preheating and Scarfing Procedures

Preheating of material to be scarfed is being done in several ways, namely:

1. Catch the steel at the desired temperature, while it is cooling from a previous operation such as forging or rolling.
2. Place material on piles of hot steel.
3. Soak in hot water rinse tanks in pickling departments or in hot water tanks especially built for the purpose with and without automatic temperature controls.
4. Heat in normalizing or annealing furnaces or specially built pit type furnace.
5. Heat in specially built continuous type furnaces.

Of these preheating methods, item 5 naturally is the most efficient, since it makes possible any temperature of preheating which may be desired and provides a rapid and economical production operation. In one such installation, now being used, cold blooms and billets are passed through an oil fired heating chamber on an endless chain and are discharged at a temperature which has been found adequate for any of the higher carbon or alloy grades being scarfed. Due to the cost of installation, the continuous type of furnace (item 5) as yet is only used in plants of large production.

Catching the steel in a cooling operation (item 1) is of course less satisfactory because of lack of temperature control. Heating in hot water tanks (item 3) has a very limited application because of limitations in temperatures attainable.

In most cases, it will be found that an ordinary bottom fired pit type furnace, (item 4) which is economical to install and operate, will be suitable for preheating of all grades which can be scarfed.

In preheating for scarfing, an adequate factor of safety lies in using a standard preheating temperature which experience has shown will normally cover all conditions tending to make scarfed billets susceptible to rupturing.

From experience, it has been found that, for most steels, preheat temperatures up to 400 F, will be sufficient, providing scarfing operations are started at once and completed without delay. In preheating with low temperature, a simple rule to follow is to allow for heat penetration at the rate of one inch per hour with a minimum of two hours in all cases. This rule was established as a result of a great many studies and is shown in the following table:

Preheating Schedule for Various Sections

Section size, in.	*Minimum preheat time, hr*
2 x 2	2.0
3 x 3	2.0
4 x 4	2.0
5 x 5	2.5
6 x 6	3.0
7 x 7	3.5
8 x 8	4.0
9 x 9	4.5
10 x 10	5.0

Some mills, for special reasons of their own use a preheat of as high as 700 F for certain grades of steel. If at all possible, preheat temperatures should be kept under 400 F, for with temperatures higher than this, cleaning of slag from the scarfed surfaces becomes more difficult and efficiency of scarfing operator is reduced due to high heat.

Annealing after rolling will not substitute for preheating before scarfing. It will lessen the tendency towards transverse cracking of the steel, but will not eliminate the "lace curtain" cracks sometimes obtained

after scarfing. Preheating is the only known preventive for the "lace curtain" effect.

In determining preheat temperatures to be used it is well to consider certain conditions peculiar to particular operations. These conditions include characteristics of mill heating furnaces, in which steel will be heated for rolling after scarfing and size and length of pieces to be scarfed.

If mill heating conditions are drastic, it is important that a less highly stressed material be charged into the furnace than would be the case if the scarfed material were to be heated gradually. In general, the greater the danger of cracking, the longer the piece being scarfed.

Weather conditions must usually be considered in setting up preheating schedules. A steel which can be successfully scarfed without preheating in warm weather may crack if scarfed without preheating in cold weather. In other words, a steel which can be successfully scarfed with 300 F of preheat in the summer may require 400 F in the winter. Winter period is generally considered from November to April inclusive and summer from May to October inclusive, with modifications to suit the locality. A typical example of summer and winter preheating schedules used by one plant having several different finishing mills is shown in Tables I and II respectively.

In scarfing of ingots, the weakness of an "as-cast" structure should always be recognized. Ingots of any grade and especially of the higher carbons and alloys, should be scarfed at a temperature sufficient to insure against stress relief cracking. The proper handling procedure for this type of material can be gauged by the analysis.

For checking the temperature of preheated steel at the scarfing beds, it is well that the inspector or some other person in charge, be supplied with contact thermocouples, temperature pills or alloy sticks (made of tin, lead, bismuth and cadmium, with proportions varied to get desired temperature range). Any material which falls below the required temperature should be returned to preheating furnace for reheating.

No preheated steel that has been partially scarfed and allowed to cool should be scarfed without reheating again.

Pickling of scarfed steel should be done with caution inasmuch as the action of the acid will attack the hardened area developing an "alligator hide" type of defect on the highly stressed surface. Some companies have, in their particular cases, found that this is true in the case of carbon steels of .50 per cent carbon and over and alloy steels of .40 per cent carbon and over which have not been preheated prior to scarfing. For this reason,

TABLE I

Scarfing Schedule of Various SAE Grades
Summer Months

Type	20 in. mill		18 in. mill		12 in. mill		8 in. mill	Forge	
	6 in. x 6 in. to 11 in. x 11 in.		6 in. x 5 in. to 7 in. x 9 in.		4 in. x 4 in. to 5 in. x 5 in.		2½ in. x 2½ in.	6 in. x 6 in. and up	
	Cold	Hot	Cold	Hot	Cold	Hot	Cold	Cold	Hot
Plain carbon	1050	1070	1050	1065	1045	1065	1040	1050	....
C.M.S.*	X1340	....	X1340	....	X1340	T1350	X1335	X1340	....
C. Mn.	T1340	....	T1340	T1350	T1335	....	T1330	T1340	....
½% Ni.	....	....	....	....	....	....	....	....	....
1½% Ni.	2145	....	2145	....	2120	....	....	....	....
2% Ni.	.40C	....	.40C	....	.20C	....	....	....	....
3½% Ni.	2350	....	2350	....	2320	2350	2330	2330	....
5% Ni.	2515	....	2515	....	2515	....	....	....	....
1¼% Ni. Cr.	3150	....	3140	3150	3120	3150	....	3140	3150
1¾% Ni. Cr.	3250	....	3240	3250	3220	3250	....	3235	3250
3½% Ni. Cr.	3335	....	3335	....	....	3335	....	3335	....
3% Ni. Cr.	3435	....	3435	....	3415	3435	....	3435	....
Cr. Mo.	4150	....	4140	4150	4115	4150	....	4135	4150
Cr. Ni. Mo.	4320	4340	4315	4340	4315	4345	....	4320	4345
1¾% Ni. Mo.	4650	....	4640	....	4620	4650	....	4640	....
3½% Ni. Mo.	4820	....	4820	....	....	4820	....	....	....
C. Cr.	5150	....	5140	5150	5115	5150	....	5135	5150
Cr. V.	6150	....	6135	6150	6115	6150	....	6135	6150
Amola	.35C	....	.35C	.65C	.20C	.65C	....	....	....
Nitralloy	....	.45C	....	.45C	....	....	....	....	....
1¼% Ni. Cr. Mo.	....	3170	....	....	....	....	....	....	....

*1100 Series — same as 1300 series.

1. Above list shows top carbon ranges on SAE grades for hot and cold scarfing.
2. Carbon in SAE grades above ranges shown and all grades not shown are to be processed in regular manner until otherwise instructed.

pickling can be used as a check to determine whether or not the steel was properly preheated.

Stress relief cracks may be developed on the surface of the steel, either from cooling after improper scarfing procedure or on heating up in the rolling mill furnace. The relief cracking is discernable in the roughing line of the mill appearing as cross checking, and will carry through to the finished size in defects generally known as "crows feet." This condition can only be eliminated by preheating before scarfing.

The partly oxidized material, commonly known as fin, if remaining on the billet after scarfing will carry through to the finished product and appear as scabs and slivers unless the rolling mill furnace has the ability to scale it off. This is often the case in the rolling of certain alloys, where rolling temperature is kept low in order to hold decarburization to a minimum. When this is the case, care must be taken in scarfing to insure a minimum of fin. Types of steel having high percentages of nickel, molybdenum and copper are very susceptible to finning, especially in the low carbon ranges, since these elements resist oxidation. A good operator, by using proper torch technique, equipment and fuel pressures, can scarf almost any steel and leave practically no fin. In certain mills, due to heating and rolling limitations, it is necessary to remove fin if any is produced.

All the aforementioned factors must be taken into consideration and if applied to each mill individually, will insure first class surfaces on the finished products.

In some mills, a combination of lack of familiarity with the process, the usual resistance accorded a new procedure and either the lack of time or the unwillingness to make proper investigation has resulted in a tendency to attribute any defective surface on a finished product to the fact that the semi-finished material was scarfed. It may be well to point out, in view of the marked success attained in scarfing of high carbon and alloy steels, that before a defective surface on a finished product is attributed to scarfing, it is advisable to investigate all phases of the manufacturing procedure.

As an illustration of this point, let us briefly review the report of one of many investigations made by the metallurgical department of a large alloy steel mill. This investigation was made to determine, if the defects in the finished product were actually caused by the scarfing operation or if the fault might lay in some other part of the manufacturing process.

One of the main reasons for suspecting that something other than scarfing was causing the defects was the fact that the defects were only showing up occasionally, although scarfing was the only method of cleaning used. Their investigation of several grades of alloy steel

TABLE II

Scarfing Schedule of Various SAE Grades
Winter Months

Type	20 in. mill		18 in. mill		12 in. mill		8 in. mill		Forge	
	6 in. x 6 in. to 11 in. x 11 in.		6 in. x 5 in. to 7 in. x 9 in.		4 in. x 4 in. to 5 in. x 5 in.		2½ in. x 2½ in.		6 in. x 6 in. and up	
	Cold	Hot	Cold	Hot	Cold	Hot	Cold	Hot	Cold	Hot
Plain carbon	1040	1070	1040	1065	1040	1065	1030	1040	1040	1050
C.M.S.*	X1340	X1350	X1340	X1350	X1325	X1340	X1320	X1335	X1335	X1340
C. Mn.	T1335	T1350	T1335	T1350	T1325	T1350	T1320	T1330	T1330	T1350
½% Ni.	....	....	....	....	....	....	....	....	....	....
1½% Ni.	2140	2145	2140	2145	2120	....	....	....	....	....
2% Ni.	.30C	.40C	.30C	.40C	.20C	....	....	....	....	....
3½% Ni.	2335	2350	2335	2350	2320	2350	....	....	2330	2350
5% Ni.	2515	....	2515	....	2515	....	....	....	2515	....
1¼% Ni. Cr.	3130	3150	3130	3150	3115	3150	....	....	3130	3150
1¾% Ni. Cr.	3230	3250	3230	3250	....	3250	....	....	3230	3250
3½% Ni. Cr.	....	3335	....	3335	....	3335	....	....	....	3335
3% Ni. Cr.	....	3435	....	3435	....	3435	....	....	....	3435
Cr. Mo.	4130	4150	4130	4150	....	4150	....	....	4120	4150
Cr. Ni. Mo.	....	4370	....	4345	....	4345	....	....	....	4345
1¾% Ni. Mo.	4620	4640	4620	4640	....	4650	....	....	4620	4650
3½% Ni. Mo.	4820	....	....	4820	....	4820	....	....	....	4820
C. Cr.	5130	5150	5130	5150	5115	5150	....	....	5130	5150
Cr. V.	6130	6150	6130	6150	6115	6150	....	....	6130	6150
Amola	.20C	.65C	.20C	.65C	....	.65C	....	....	.20C	.65C
Nitralloy	....	.45C	....	.45C	....	....	....	....	....	....
1¼% Ni. Cr. Mo.	....	3170	....	....	....	....	....	....	....	....

*1100 Series — same as 1300 series.

1. Above list shows top carbon ranges on SAE grades for hot and cold scarfing.
2. Carbon in SAE grades above ranges shown and all grades not shown are to be processed in regular manner until otherwise instructed.

(Table III) and the conclusions drawn are as follows:

Microexamination

Heat No. 1 — SAE3240 — Scarfed size 9 in. x 9 in. rolled to 4½ in. square.

A.—Defective surface illustrated in Figure 1.

B.—Typical defects on the finished size are illustrated in Figures 2, 3 and 4.

C.—Slight decarburization on defective side would indicate that defect was not present in furnace before rolling. As rolled grain size shows larger grain condition than present at 180 degrees opposite defective surface (Figure 5).

D.—Depth of decarburization, .015/.020 in., indicates a greater scaling action and a possible higher temperature on this side when compared to .025/.030 in. decarburization on opposite surface (Figure 5). Any hardened or strained condition that may have existed in the as-scarfed billet apparently has been relieved by reheating in the mill furnace as no indications are shown in the photomicrograph.

E.—Short straight seams indicated on Figure 1, where in the direction of rolling, were found to be defects not removed from the scarfed billets.

Heat No. 2 — SAE 4340 — Scarfed size 8 in. x 8 in. rolled to 4¾ in. round.

A.—Defective surface illustrated in Figure 6.

B.—Photomicrographs taken through typical defects (Figure 7) indicate no decarburization present and therefore defect occurred during rolling.

C.—A comparison of the as-rolled grain size (Figure 8) shows a finer grain than the uniformly large grain shown 180 degrees opposite defective surface, (Fig-

TABLE III

Grades of Steel Investigated

Heat No.	SAE grade	Ladle analyses							
		C.	Mn.	P.	S.	Si.	Ni.	Cr.	Mo.
1	3240	.40	.80	.020	.024	.19	1.29	.69	.....
2	4340	.40	.68	.014	.016	.22	1.83	.84	.32
3	5140	.40	.74	.020	.033	.17	.....	.95	.....

TABLE IV

General Ranges of Some Alloy Analyses Scarfed

	C.	Mn.	P.	S.	Si.	Ni.	Cr.	Mo.	V.	W.
Hi. C. Ni.	.35	.30	.02	.03	.10	.15	.10	....	....	....
	1.10	.80	.10	.05	2.60	2.75	.95	....	....	....
Hi. C. Cr.	.97	.20	.30	....	.035	.15	3.50	....	....	....
	1.00	.30	....	....	....	.30	....	....	....	....
Hi. C. S.	.95	.15	.45	.75	.15	....	....	....	....	....
	1.00	.30	....	1.75	.30	....	....	....	....	....
Hi. Mn.	.33	10.50	.03	.04	.31	....	.48	....	....	....
	....	....	.04	.05	....	....	....	....	....	....
Hi. Si. Ni.	.76	.20	.03	.03	.10	1.15	.15	....	....	....
	.82	.60	....	....	2.60	1.50	.20	....	....	....
Hi. Mn. Hi. S.	.33	10.50	.03	7.90	.03	....	....	....	....	....
C. Cr.	.30	.20	.02	.15	.02	....	.80	....	....	....
	1.18	.90	.04	.40	.04	....	3.50	....	....	....
Mn. Su.	.33	1.43	.02	.08	.07	.12	.05	.06	....	....
	.55	1.65	.03	1.26	.22	.21	.14	....	....	....
Amola	.27	.74	.02	.02	.02	.10	.09	.18	....	....
	.97	1.42	.03	.03	.04	.19	.22	.75	....	....
Mn. Mo.	.17	.75	.03	.03	.15	....	.50	.10	....	....
	.70	1.15	.04	.10	.30	....	.60	.90	....	....
Spec. Ni.	.19	.80	.015	.03	.05	.10	.05	.05	....	....
	.49	1.90	.025	1.37	.26	1.50	.64	.08	....	....
Ni. Cr.	.30	.20	.02	.15	.02	....	.80	....	....	....
	1.18	.90	.04	.40	.04	....	3.50	....	....	....

Figure 1 — Heat No. 1 — SAE 3240 — Photograph showing defective surfaces on finished bar.

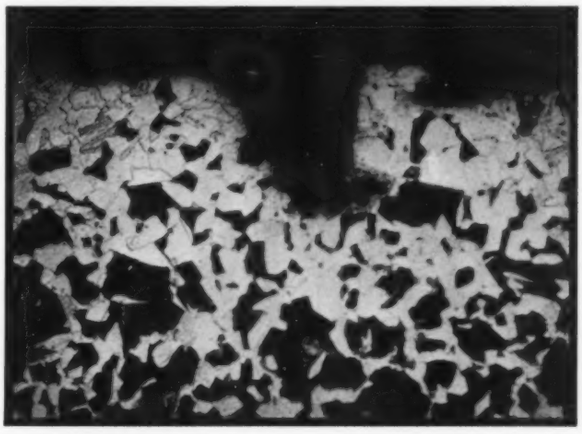
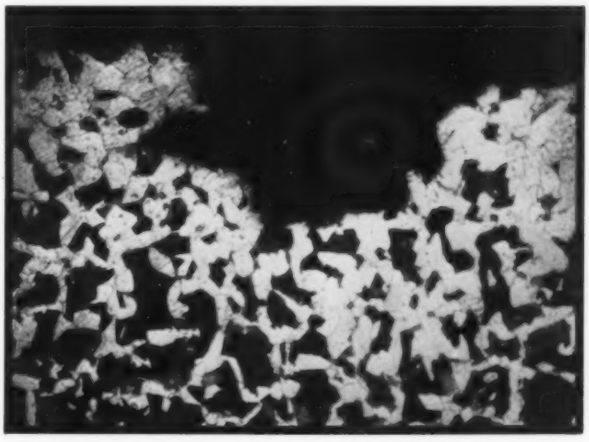


Figure 2 — Photomicrograph of one side of V-shaped defect showing decarburization .015/.018 in. 10 per cent Nital etch x 100.

▲

Figure 3 — Photomicrograph of other side of V-shaped defect showing decarburization .015/.018 in. 10 per cent Nital etch x 100.



ure 9). This would tend to indicate a cold side on a billet. Thus, due to an uneven flow of the outer surface, a strain was set up causing a rupture during the rolling.

Heat No. 3 — SAE 5140 — Scarfed size 6 in. x 6 in. rolled into $3\frac{5}{16}$ in. round.

A.—Defective surface illustrated in Figure 10.

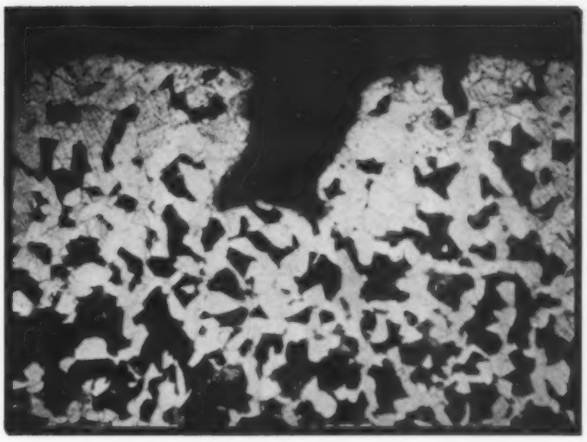
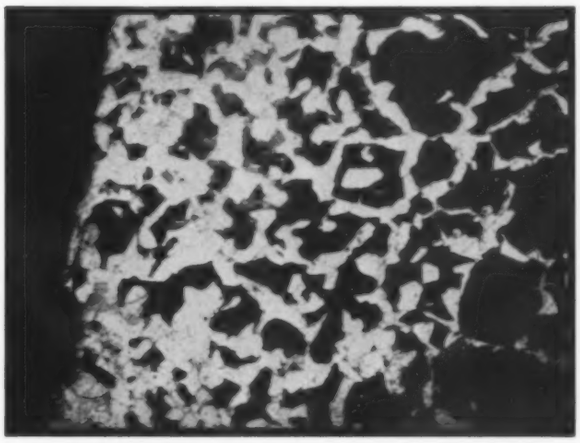


Figure 4 — Photomicrograph of typical defect showing decarburization .018/.020 in. 10 per cent Nital etch x 100.

▲

Figure 5 — Photomicrograph of as-rolled structure 180 degrees opposite defective surface showing decarburization .025/.030 in. 10 per cent Nital etch x 100.



B.—Photomicrographs taken transversely through typical defects. Figures 11, 12 and 13 indicate the same existing condition as present on heat No. 1.

Data and Conclusions — The method of firing in the mill furnace subjects the front and top side of the billet to more drastic conditions of temperature and atmosphere than the bottom and back side. When production is increased over normal conditions, which is the present situation, the tendency is to carry a higher furnace temperature in order to drive the heat into the bottom and back side of the billet. This would mean the top side (and possibly the front side, depending on the location of the billet on the hearth) would be at a much higher temperature than the bottom and back sides.

Considering both the conditions that exist in the mill furnace under the increased production and the data presented, it is felt that the mill heating conditions were responsible for the defective surfaces on the finished materials.

As a result of this investigation, heating procedure at this mill was changed and no further trouble in defective surfaces other than normal were encountered. Chances are that if the officials had not decided to get

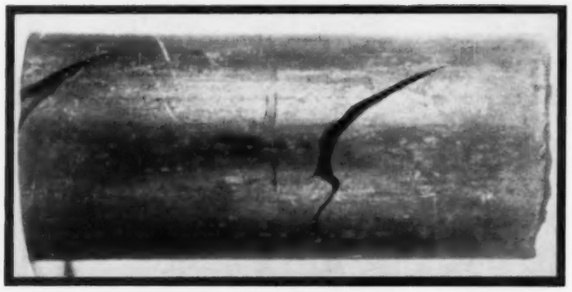


Figure 6 — Heat No. 2 — SAE 4340 — Photograph showing defects in finished bar.

Figure 7 — Photomicrograph showing structure at defect. 10 per cent Nital etch x 100.

▲

Figure 8 — Photomicrograph of as-rolled grain size at surface of defective side. 10 per cent Nital etch x 100.

▲

Figure 9 — Photomicrograph showing as-rolled grain size 180 degrees from defective surface.

to the bottom of the cause, defective surfaces would have continued, even if scarfing operations were discontinued.

Range of Analyses

As previously stated, scarfing today is being done on practically all grades formerly cleaned by chipping and on a large number of grades formerly swing ground. With the exception of corrosion and heat resisting alloy steels practically every SAE grade of steel and many special grades not covered in the SAE line-up are being scarfed.

While a complete list of the various types of special steels which are being scarfed cannot be shown here, due to the many various combinations of analyses used, a few examples of the general analysis ranges are illustrated in Table IV.

Scarfing Costs

The cost of scarfing per ton of steel will, of course, differ in the various plants depending upon several conditions such as type and quality of steel, section and size, amount of conditioning given, labor rates, inspection and handling conditions.

To quote an exact cost per ton for scarfing, as compared to other cleaning methods, would be impossible

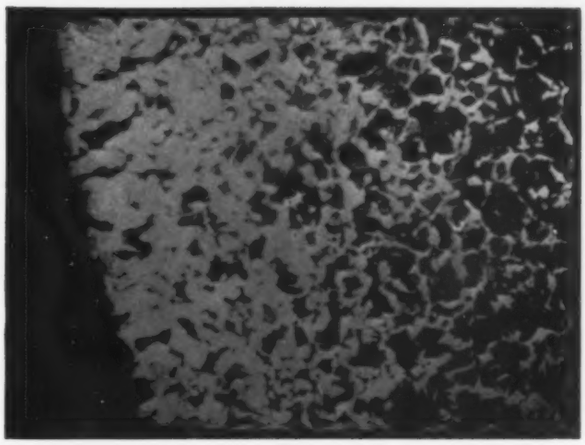


Figure 13 — Photomicrograph of as-rolled structure 180 degrees opposite defective surface. 10 per cent Nital etch x 100.

Figure 10 — Heat No. 3 — SAE 5140 — Photograph showing defective surfaces on finished bar.

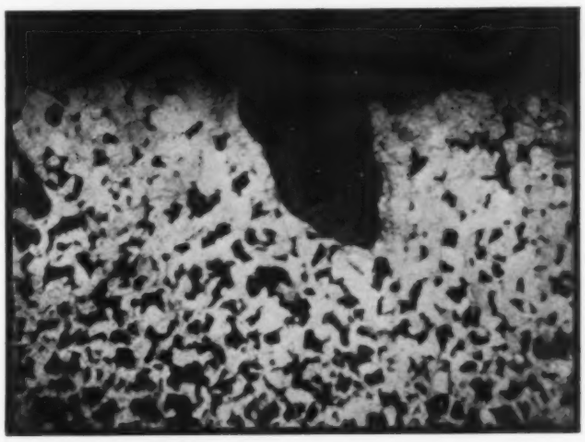
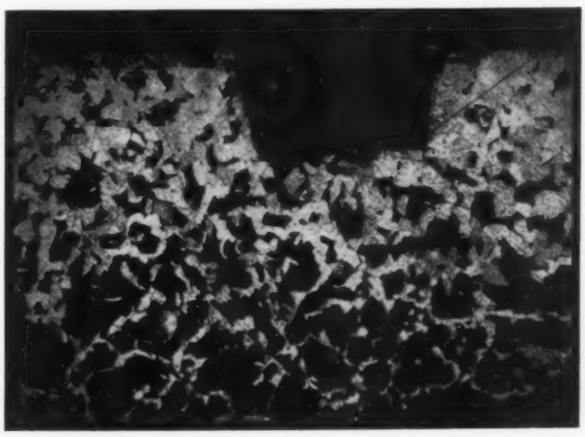


Figure 11 — Photomicrograph of typical defect showing decarburization .020/.025 in. (Mounting metal present in defect). 10 per cent Nital etch x 100.

Figure 12 — Photomicrograph of typical defect showing decarburization .015/.020 in. (Mounting metal present in defect). 10 per cent Nital etch x 100.



except in certain cases where the steels conditioned were identical in every respect.

A comparison of cleaning costs on a percentage basis for three alloy steel plants, each using three different methods of cleaning, are shown in Table V.

Table V

Comparison of Steel Conditioning Costs

Plant	Hand scarfing	Hand chipping	Swing grinding
1	100%	159%	431%
2	100%	187%	526%
3	100%	189%	447%
Average	100%	175%	468%

These figures are not for any given conditions but are based on average conditions over the period of a year regardless of variations in class of conditioning, size, grade of steel or inspection.

Advantages of the Oxyacetylene Process

Torch deseaming, or scarfing, of high carbon and alloy steels when compared to other cleaning methods, offers many advantages, the most important being as follows:

1. It is several times faster than mechanical chipping, hand chipping or swing grinding, with increased production at the rate of approximately 6, 8 and 15 times respectively, having been obtained.
2. It offers the opportunity for large savings in conditioning costs over any other cleaning method.
3. It enables salvaging of much material which formerly had to be scrapped due to prohibitive cleaning costs.
4. It presents facilities to condition blooms, bars, billets and slabs, so as to insure perfect quality of surface when the steel is reworked to finished products.
5. It makes possible a reduction in inventory, stock and handling facilities.
6. It provides a reduction in delays in assembling stock for rolling mill schedules, thus expediting shipments to customers.

DISCUSSION

RUSSELL HUNT, Assistant Superintendent of Rolling Mills, Carnegie-Illinois Steel Corporation, Duquesne, Pennsylvania
G. D. WINLACK, Steel Plant Engineer, Air Reduction Sales Company, New York, New York
M. J. CONWAY, Special Engineer, Lukens Steel Company, Coatesville, Pennsylvania
J. G. COOPER, Inspection Department, Carnegie-Illinois Steel Corporation, Duquesne, Pennsylvania
H. M. FLAHERTY, General Foreman of Scarfing, Carnegie-Illinois Steel Corporation, Duquesne, Pennsylvania

RUSSELL HUNT: There is one question I would like to ask: On 1½ in. billets, how do you keep them from bowing? We have trouble with them in scarfing.

G. D. WINLACK: There are several ways you can reduce bowing. As far as I can recall, the first method was to scarf on one side, turn the billet over and scarf on the opposite side. Other methods include the use of smaller scarfing tips to reduce the width of heated area and working with lower pressures. Many mills roller straighten small billets before entering the reheating furnace.

MEMBER: I would like to ask Mr. Winlack whether or not he considers any treatment necessary after scarfing on high alloy steels, particularly whether or not it is necessary to slow-cool after the scarfing is completed.

G. D. WINLACK: I will answer that in this way: If the steel has been handled properly prior to the scarfing —in other words, slow-cooled the way it should be—you don't need any handling after scarfing, but for safetys' sake, on the high carbon for certain alloys we always find it preferable to do what we call packing. In other words, we bunch the billets and let them slow-cool.

M. J. CONWAY: Mr. Winlack has delivered a well prepared informative paper, which will take more than one reading to thoroughly digest, but as is usual with a paper of this type there are always other questions in the mind of the operator, which, while they may have been answered in a general way need specific explanation and I will refer to cost.

Mr. Winlack mentioned a ratio of 1 to 1¾ scarfing to chipping, and of 1 to 4.68 scarfing to grinding. What is included in the base scarfing rate of one in making these comparisons? Are all of the preheating costs, such as furnace upkeep, fuel, additional handling, etc., included in this base rate?

In referring to the analysis of the various steels successfully scarfed, I did not hear Mr. Winlack mention chromium content, and I would appreciate his opinion on the chromium content of steel which can be successfully flame conditioned and the recommended conditioning temperature.

In such plants as treat relatively small tonnages of alloy steel, the problem of special furnaces for preheating preparatory to flame conditioning naturally would be a serious one. As a substitute, has Mr. Winlack had experience with a portable hood, gas or oil fired, and with automatic temperature control, thereby heating the steel at the location where it is to be later flame conditioned.

G. D. WINLACK: I believe the first question was on the cost. I may say that these figures were confidential in the fact that I used percentages. However, those figures include direct and indirect costs. In other words, everything is included. The cost of preheating, maintenance and fuel are included. In other words, that is the total cost. Will you repeat your next question?

M. J. CONWAY: Mr. Winlack, I inquired if you had experience with a portable insulated hood, which could be placed over a chunk of steel, such hood possibly to be automatically controlled for temperature.

G. D. WINLACK: Some steel companies have used various portable means. At several points, we have used annealing covers from sheet mills and put gas burners in them, both with and without control.

M. J. CONWAY: The chromium content.

G. D. WINLACK: My experience has been that it is roughly up to 5 per cent. That is with pretty high carbons.

M. J. CONWAY: In cases where the carbon was reduced to say, fifty points, could there be an increase in the chromium content?

G. D. WINLACK: Personally, I believe there could.

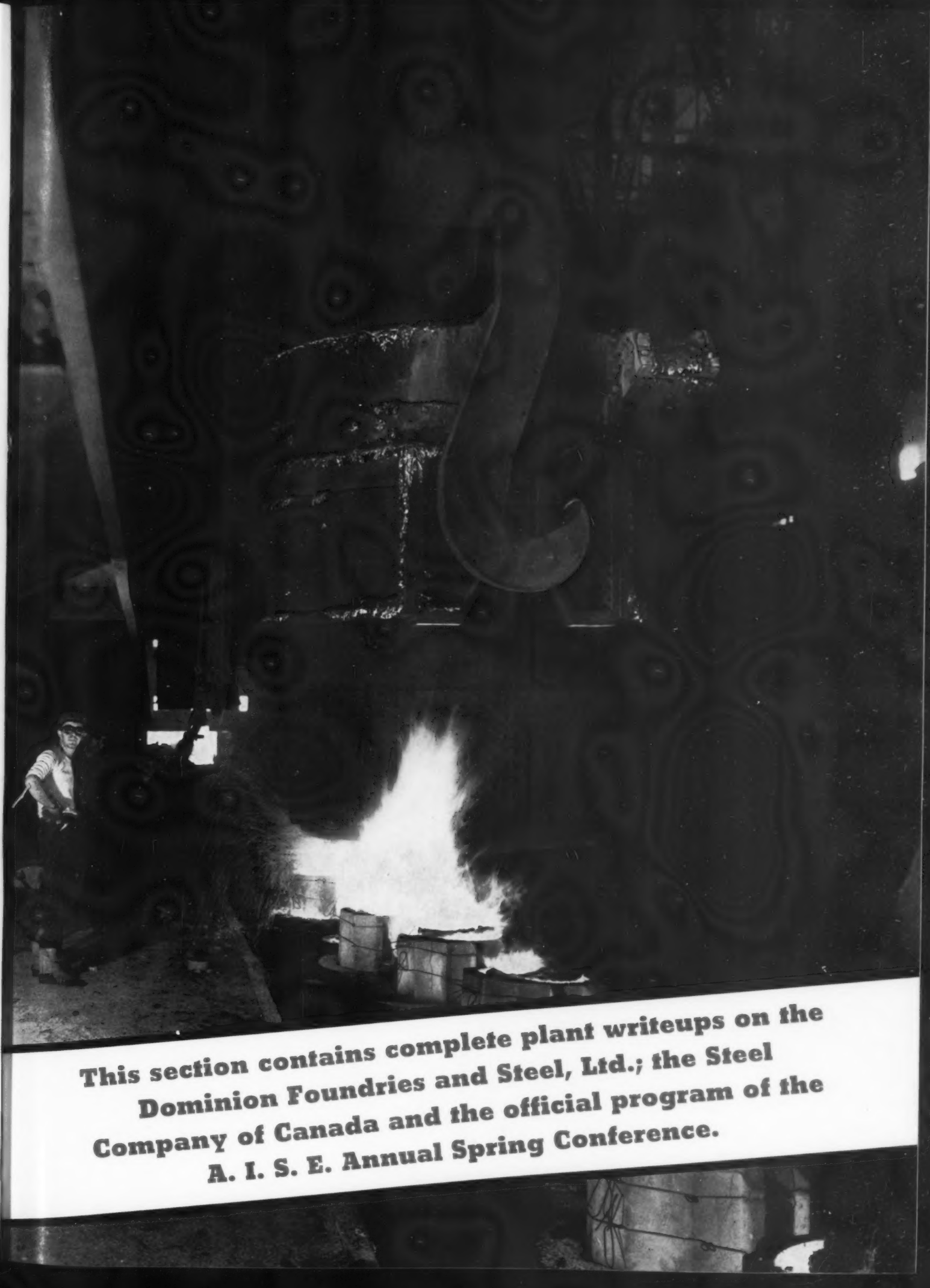
J. G. COOPER: How do you arrive at your decision that scarfing is more economical than machining?

G. D. WINLACK: Again that depends on the grade of steel you are on and the type of conditioning used. I might say, if scarfing was not in the picture, much steel would be scrapped and not sent to the machine. It would cost too much to clean it up. On the same amount of work on a piece of steel, I think you will find the figures I have quoted are right.

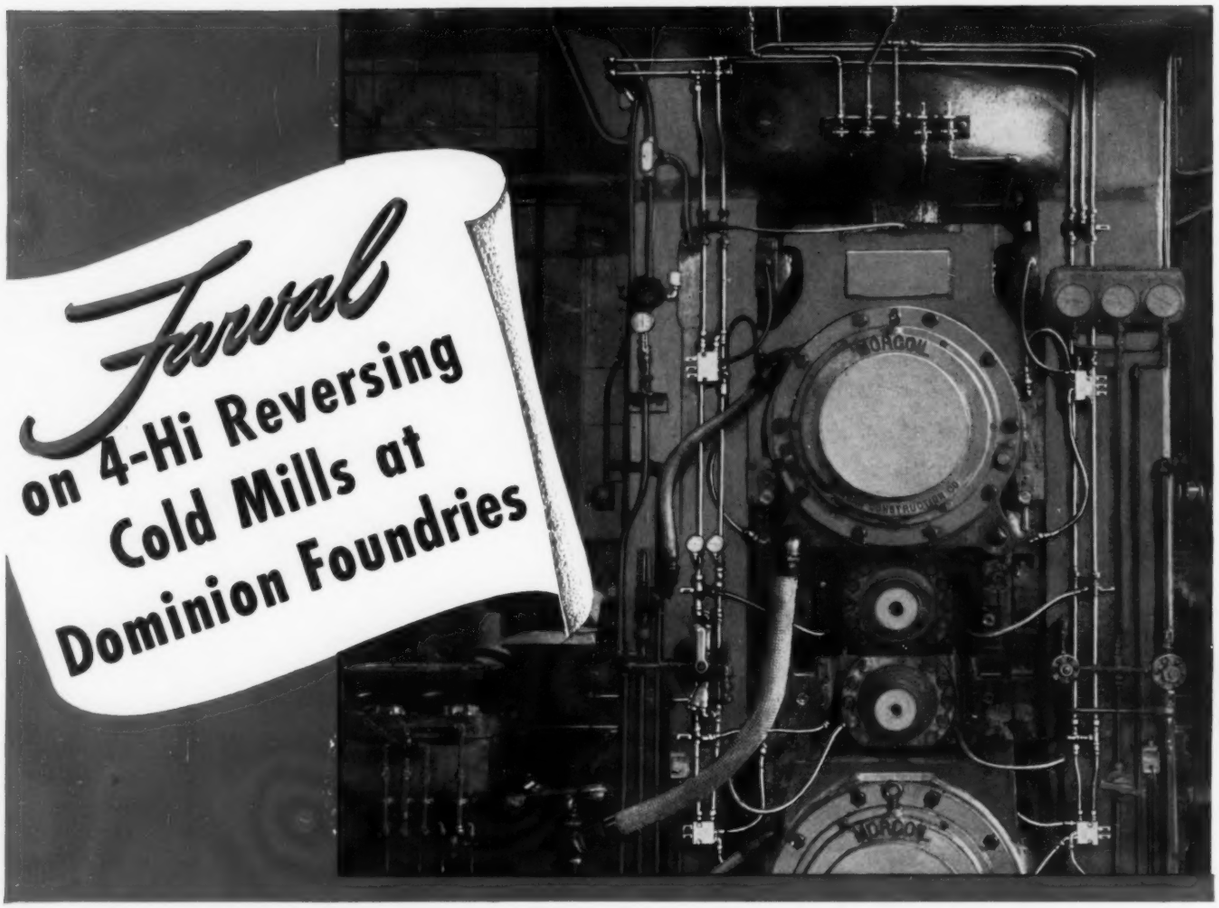
J. G. COOPER: I don't think we would agree with that. We think the machines are fully as fast as scarfing and more economical for large sections —5 in. x 5 in. and over.

H. M. FLAHERTY: When you run your costs on machining and scarfing, how do you take your costs? Is it taken by the tonnage or by the lb of metal removed?

G. D. WINLACK: It has been figured three ways; tonnage, lb of metal removed and surface area conditioned.



This section contains complete plant writeups on the Dominion Foundries and Steel, Ltd.; the Steel Company of Canada and the official program of the A. I. S. E. Annual Spring Conference.



Farval was selected for the lubrication of their new 4-Hi Reversing Cold Mill by Dominion Foundries & Steel, Ltd., following the successful performance of Farval on the 4-Hi Reversing Mill installed more than 5 years ago.

With Farval, lubricant is delivered under high pressure in exact measured quantities from one Central Station and—not a bearing is missed.

Labor of oiling is cut at least 90%—repairs and maintenance are reduced to a minimum—and mill delays caused by lack of lubrication are eliminated—thus insuring maximum production schedules.

Savings in power and reduced consumption of lubricant always follow a Farval installation. In fact, few if any investments in Mill equipment will pay a quicker or greater return than a Farval Centralized System of Lubrication.

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FARVAL

CENTRALIZED SYSTEMS OF LUBRICATION

DOMINION FOUNDRIES and STEEL, Ltd.

By T. J. Ess, with personnel photographs by J. R. Scott

▲ DOMINION Foundries and Steel, Ltd. at the present time offers a fine example of the change-over of plant operations and practices occasioned by armament programs. With a normal peace-time production of electric steel castings, forged railway axles, plate and tin plate, the company has been called upon to devote a great part of their efforts to a more direct form of armament production.

The facility with which the company's activities were switched to a war footing is more or less a reflection of the flexibility with which they have fitted their production to changing requirements in the past. From the founding of the company in 1912 by C. W. Sherman, president, the history indicates a constant program of progress and pioneering in spite of comparatively small size. The original plant consisted of a single 20-ton acid open hearth furnace, producing steel for foundry purposes. During World War I, the company entered into the production of steel shell blanks, and eleven small open hearths were installed. Back on a peace-time footing, two small electric furnaces were installed for alloy casting production, and in 1920 a plate mill was built, which, after a period of idleness, began the production of sheared plate, and, subsequently, of hot rolled strip. In 1940 a four-high reversing hot mill stand was placed in tandem with the plate mill. Cold reduction mills afford facilities for the production of tinplate by the cold reduction process, which is not used at any other plant in Canada. During the past two years two more electric arc furnaces were installed, which, in conjunction with various auxiliary units, have increased materially the capacity for armament production.

Located in the north-east section of Hamilton, and

C. W. SHERMAN

President

Open hearth furnaces are of unusual design, having straight roofs, without slopes or knuckles.

F. A. LOOSLEY

Works Manager

about ¾ of a mile from the shore of Burlington Bay, the plant is divided into two main sections by the tracks of the Toronto, Hamilton and Buffalo Railway. One section includes the scrap yard, the open hearth, and electric furnace departments, the foundry and its auxiliaries, the forge shop, etc. The second section houses the soaking pits, hot mill, strip and plate finishing departments, etc.

Steel Production

Four basic open hearth furnaces, tapping 60-ton heats, provide a total capacity of 16,000 tons of ingots per month. These furnaces are about 50 ft in length, with bath measurements of 28 ft x 14 ft x 22 in. A rather unusual point in the design of these furnaces is the fact that the roof, from end to end of the furnace, is straight, with no slopes or knuckles at any point. A simple arch, 9 in. thick and stepped up to 12 in. thick along each side, is sprung from the front and back walls. Flame direction, therefore, depends entirely upon the directional effect of the oil burner.

The furnaces follow the Isley design, with a stack connected directly to each end of the furnace, and a fan and an ejector nozzle incorporated in each stack. Thus, the fans act alternately to supply forced draft or induced draft, according to the direction of flow through the furnace.

Regenerator design is also of unusual interest. Gases leaving the slag pocket flow in reverse bends over several vertical baffle walls, tending to throw out solid particles entrained in the gas stream. Subsequent checkerwork is arranged for horizontal gas flow through three successive passes, giving a total length of travel of about 35 ft. The volume of checkerwork totals 2667 cu ft on each end of the furnace.

Fuel oil is introduced through a compressed air atomizing burner in each end wall. It has been found that these burners provide satisfactory directional effect for a furnace of this size. Automatic controls have been applied to furnace pressure, fuel-air ratio, and reversal on two furnaces. Fuel consumption averages about 4,000,000 Btu per net ton of ingots. Furnaces are completely insulated below the charging floor level.

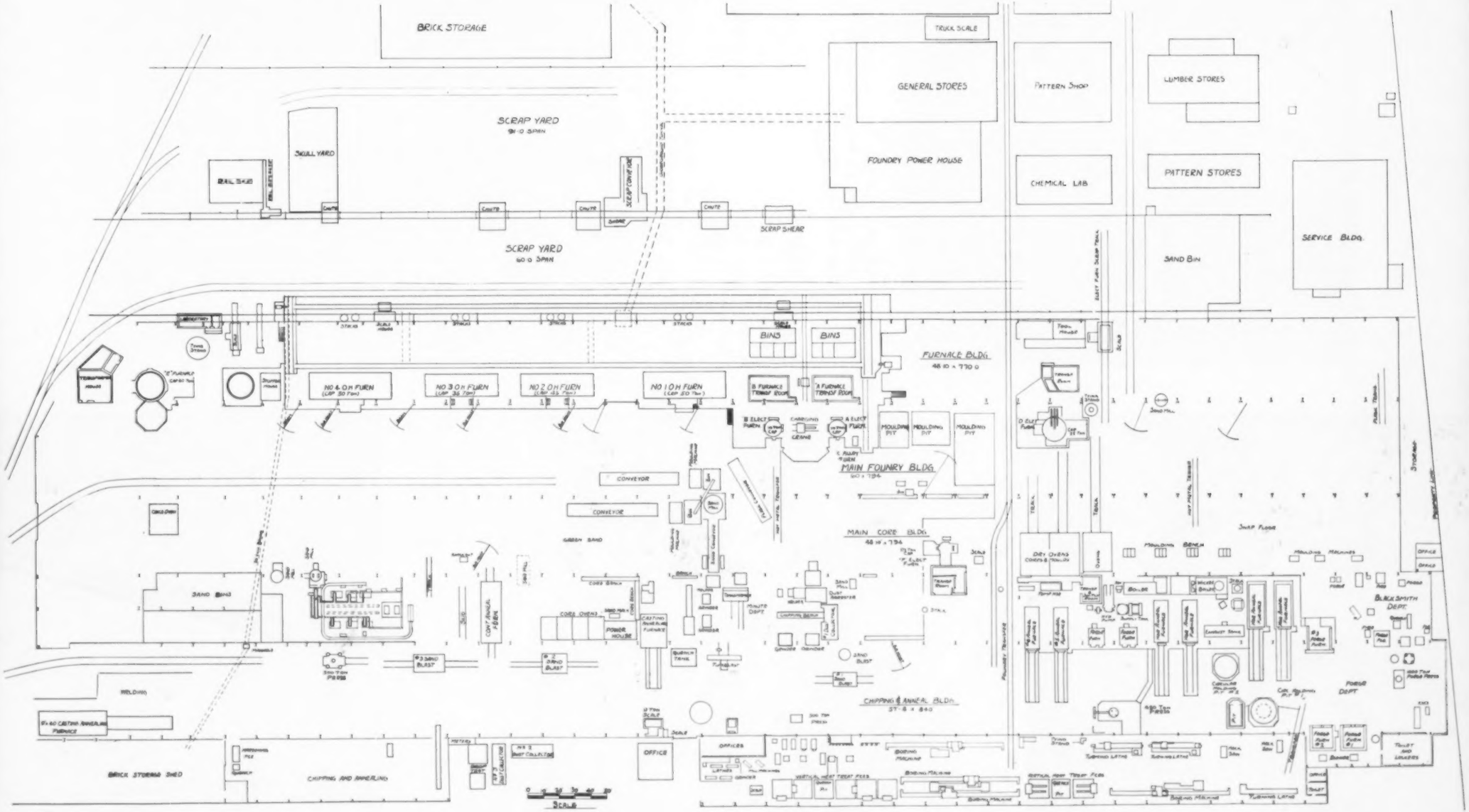
Furnace charges vary widely, running from 75 per cent scrap, 25 per cent pig iron, to practically straight scrap with coke as a carburizer. Burnt lime is used as the fluxing agent, running 3½-4 per cent of the metallic charge. Heats are produced in an average time of about 8 hr. The steel produced likewise varies widely, running .05-.50 per cent carbon and occasionally up to 1.00 per cent. Open hearth product is largely carbon steels, going into plate and tin plate, although about 25 per cent of the output is of killed grades, with some of the milder alloy specifications. The steel is all bottom poured, with ingots ranging 9-20 in. thick, 14-54 in. wide, and 500-12,000 lb in weight. Before each use, ingot moulds are internally brushed with a graphite wash.

The scrap yard, in two spans, 60 ft and 91 ft, is served by overhead traveling cranes and parallels the 48 ft 10 in. x 770 ft furnace building. Charging cars run under the one span, but at charging floor level. Scrap is placed in the charging boxes by lifting magnets on the scrap yard cranes. The charging cars are carried into the furnace building by several transfer buggies. An overhead crane with charging peel puts the scrap into the furnace.

Electric furnace steel capacity of 10,000 tons per month is provided by five arc furnaces, one of 1½ tons,

Electric arc furnaces, totaling 6000 tons per month capacity, are used for the production of high quality steels of special grades.

DOMINION FOUNDRIES AND STEEL, LTD. ★ FOUNDRY SECTION

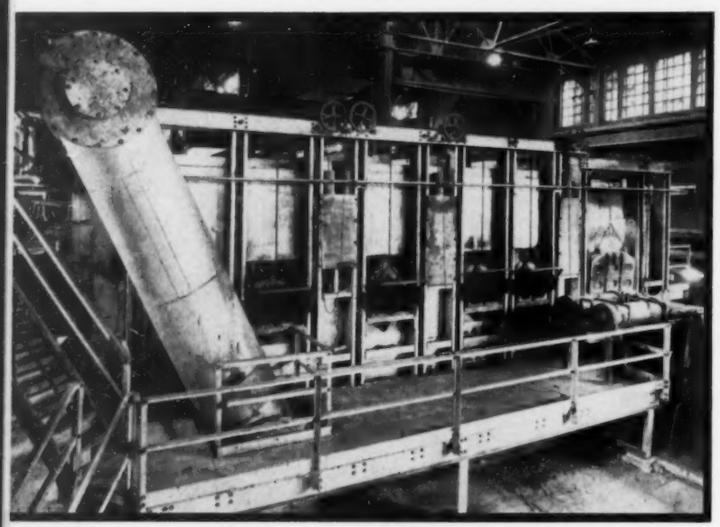


D. F. HASSEL (Right)

Assistant Works Manager

J. ATKINSON

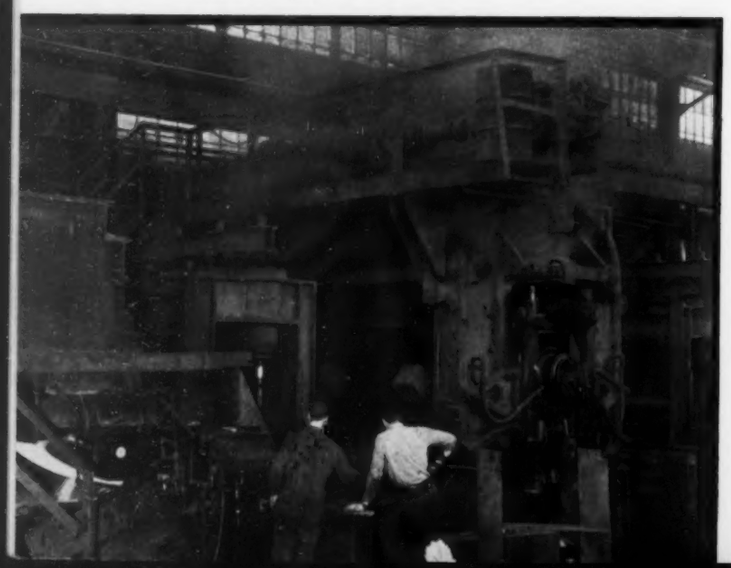
Superintendent of Open Hearth



Ingots are heated for rolling in soaking pits or in a continuous heating furnace as illustrated here.

▲

A reversing four-high mill finishes the hot rolling process. Light gauges are coiled up in hot coiling furnaces between passes.



A two-high reversing mill acts as a breakdown unit, reducing the ingot to a thickness of about four times the finished thickness.

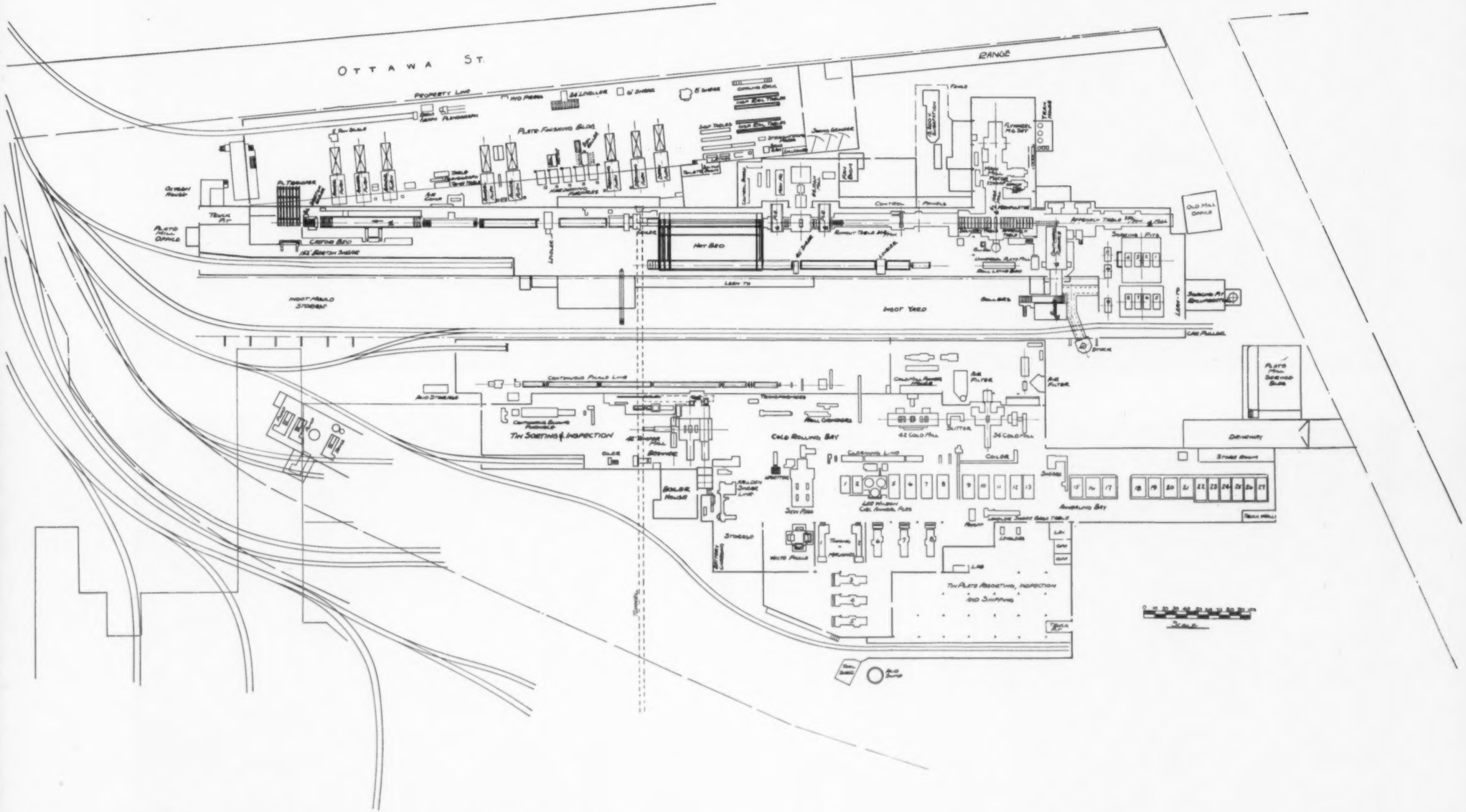
two of 10 tons, one of 25 tons, and one of 50 tons, the last unit being recently installed. Power is supplied to the furnace transformers at 13,000 volts, 25 cycles. One 10-ton furnace is equipped with three 500 kva transformers, the other, with a 2000 kva transformer. The 25-ton furnace has a 4000 kva transformer, while the new 50-ton furnace has a transformer of 12,000 kva capacity.

The 10-ton furnaces, which use 10 in. graphite electrodes, produce heats in about 4 hr, principally for foundry use. The larger units, which produce material or use in gun barrels and armor plate, require 6-6½ hr. per heat. Carbon electrodes 16 in. in diameter are used on the 25-ton furnace, while the 50-ton furnace uses 18 in. graphite electrodes. Electric furnace product is principally alloy steel — high manganese, chrome, chrome-molybdenum, etc.

Paralleling the furnace building are four bays which go to make up the foundry: the main foundry building, 60 ft x 856 ft; the core room, 48 ft 10 in. x 856 ft; a connecting building, 42 ft 2 in. x 880 ft; and a chipping and annealing building, 58 ft x 840 ft. In these buildings complete facilities for the production of a wide range of castings are installed, including sand mills, moulding benches, drying ovens, core ovens, core benches, moulding pits, moulding machines, annealing furnaces, grinding equipment, chipping benches, sand blasting equipment, miscellaneous conveying equipment, etc. In addition to the usual line of peacetime castings for railroad cars, locomotives, mill and mine machinery, etc., this department is producing castings for armament.

Here is also located the forge department, containing a 1000 ton press with three heating furnaces, a 450 ton press with two heating furnaces, six annealing furnaces, three large holding pits, etc.

DOMINION FOUNDRIES AND STEEL, LTD.



A. J. MALONE

Superintendent of Mills

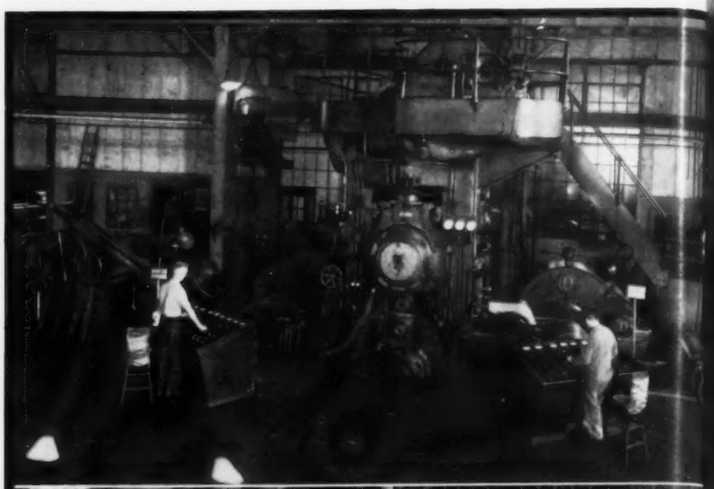
Cold reduction is carried out on single stand reversing mills, as typified by this 42 in. unit, which produces about 6½ tons per hr.

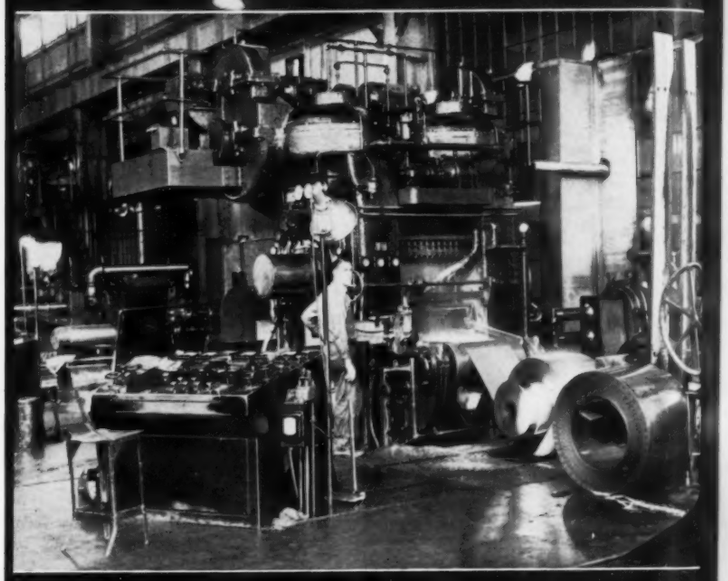
This 34 in. reversing cold mill, driven by a 1250 hp motor, averages about 4½ tons per hr of cold reduced tinplate.

Small motor rooms house the drive units of the cold mills, as well as the electrical control boards.

J. W. KNIPE

Chief Engineer





Hot Mill

Ingots are shifted into the ingot yard which parallels the hot mill building, and are subsequently reheated for rolling. Heating equipment at present consists of one heating furnace and eleven soaking pits, the latter 6 ft wide x 13 ft long x 7 ft 3 in. deep above the coke bed. The pits are fired with fuel oil with compressed air atomization, and have sprung arch covers. The regenerators are 6 ft wide x 8 ft long, and contain checkerwork about 8 ft deep. Four of the pits are designed for the Isley system of control, and a carborundum tubular recuperator is applied to seven of the pits.

The heating furnace is a continuous recuperative unit of 38 ft 9 in. overall length. The hearth is 30 ft long x 13 ft 6 in. wide. Sidewalls consist of 13½ in. of firebrick and 4½ in. of insulation. The roof is 12 in. thick plus 3½ in. of insulation. The furnace is of unusual design in that it is fired only at the top of the charging end, gases flowing to the discharge end, then down and back underneath the furnace hearth to a refractory tile recuperator. The recuperator is approximately 18 ft long, 10 ft 6 in. high, and three sections wide, each 3 ft 9 in. A cold air fan pushes the air through the recuperator, where it is heated to about 1300 F, passing on to the oil burner manifold.

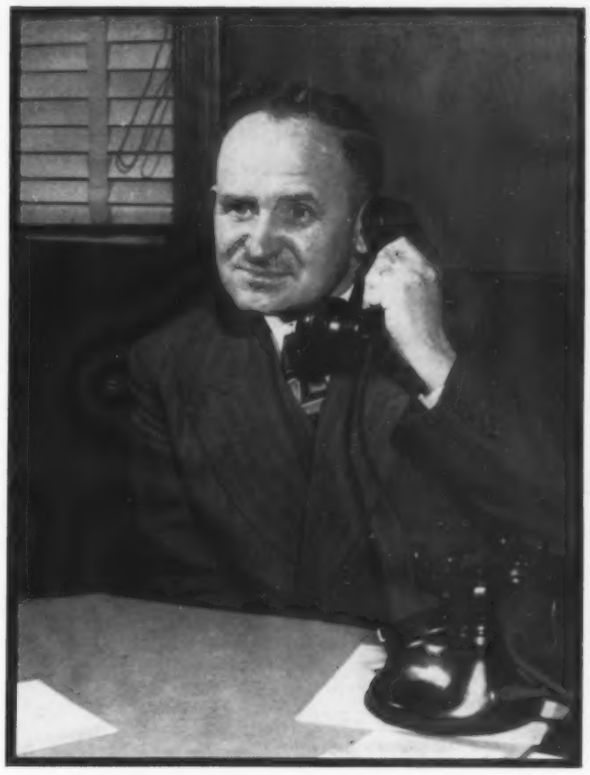
Five oil burners are spaced across the charging end wall, above the hearth. Test runs on this furnace show a heating rate on cold steel of 85 lb per sq ft per hr, with a fuel consumption of 1,800,000 Btu per net ton of mild steel. In spite of the furnace's not being underfired, the temperature differential between the top and bottom of the material is held to approximately 50 F, due to the circulation of waste gases under the hearth. The uni-directional flow of flame and steel gives a high temperature head where the steel is capable of absorbing heat rapidly without injury, with consequent high heating rates. The high degree of recuperation insures furnace efficiency. Complete automatic combustion control is installed on this furnace.

The furnace is of end-charge, side-discharge design. Ingots are moved through the furnace in a double row under the action of a double pusher, and another pusher mechanism ejects them through the side of the furnace to the mill table.

Another charging-end-fired continuous furnace is to be installed at the side of the present furnace, similar in all respects except that it is to be 50 per cent longer and of the end-charge, end-discharge type. After the second furnace is installed, the first one is to be changed to end-discharge. On the new furnace, four auxiliary "mill delay" burners, which will be located at the discharge end, will be used to hold up temperature when the rate of operation does not permit the main burners at the charging end to do so.

Two one-way fired soaking pits are also under way for this plant, to be used for heating the larger ingots.

From the pits or heating furnace, ingots at 2250-2350 F proceed down the mill approach table to a 30 in. x 84 in. universal two-high reversing stand. This stand is equipped with composition roll neck bearings and is driven directly by a 2200 hp, 0-120 rpm, 600 volt d-c motor. A mill speed up to 945 fpm is thus attained, although the approach and delivery tables operate at speeds of 214-428 fpm. Mill screws on this unit are



W. D. LAMONT
Chief Metallurgist

▲

F. BAHM
Plant Engineer

D. O. DAVIS

Superintendent of Maintenance

actuated by one 85 hp, 460 rpm, 230 volt compound wound motor. Vertical rolls, 20 in. in diameter, adjustable over a clearance range of 6½-54 in., are driven through gears from the main mill drive, and are removed from the mill when rolling sheared plate. The flywheel set which operates this motor consists of a 2000 kw, 600 volt d-c generator and an 1800 hp, 2200 volt, 369 rpm induction motor. This set, together with the main drive motor, an exciter set, an auxiliary d-c set, etc., is located in a motor room adjacent to the mill building. The machines are cooled by filtered air forced through the machines into the motor room.

About 180 ft from the two-high roughing stand is a four-high reversing stand, 23 in. and 45 in. x 86 in., which is driven directly by a 1500 hp, 70-125 rpm, 600 volt d-c motor. Power is supplied to this motor from a dual motor-generator set composed of two 1000 kw, 650 volt d-c generators, driven at 750 rpm by a 3000 kva, 13,200 volt synchronous motor. This set is located in an adjacent motor room, which also contains the main drive motor, an auxiliary d-c set, and a control set consisting of one 25 kw 125 volt generator, one 15 kw 250 volt generator, and one 100 kw 250 volt generator, all driven by a 200 kva, 2200 volt, 750 rpm synchronous motor. A flow of filtered air up through the machines into the motor room maintains machine temperatures at operating levels.

The four-high mill housings weigh approximately 90,000 lb, and have a spread at the foot of 12 ft. Cast steel separators of spool type are used, with 4 in. binder bolts at top and bottom. Housing windows are about 46 in. wide. The top rolls are balanced by a hydraulic system. The four-high stand is provided with roller bearings on the work rolls and composition bearings on the back-up. Screwdowns are operated by one 75 hp, 500 rpm, 230 volt compound wound motor. The screws are 11 in. in diameter, with a 1 in. pitch, and the mill has a maximum working lift of about 3 in.

On each side of the four-high stand, at about 22 ft distance, is an oil-fired hot coiling furnace, 6 ft long x 5 ft 3 in. wide x 5 ft 8 in. high, placed above the mill table so as to clear heavy material which is not to be coiled. Three burners are installed on each furnace. A reel, of paddle wheel type and constructed of a heat-resisting alloy, is placed in each furnace. The reels run in water-cooled bearings, and are driven by 100 hp, 475 rpm, 230 volt d-c motors, operated under a variable voltage system. When coiling, an apron is elevated from the mill table, forming a chute which carries the strip up into contact with the paddle wheel. A pair of pinch rolls, driven by a 100 hp, 475 rpm, 230 volt d-c motor, is placed on each side of the mill, between mill and coiling furnace, and aids in guiding the strip back and forth.

During hot rolling, scale is removed from the material

Sheet annealing is performed entirely in furnaces of the radiant tube type, fired with coke oven gas.

by a hydraulic descaling system. Jets are placed, top and bottom, on the delivery side of the two-high mill and on the entry side of the four-high mill. Water is supplied to the jets by two 3½ in. x 18 in., 1200 psi reciprocating pumps, which also provide hydraulic pressure for roll balance in the mills.

Rolling practice in the hot mill varies with the type of product. In any case, the ingot is roughed down in the two-high stand, using fluted rolls, and finished between smooth rolls in the four-high stand. Typical of the drafting practice is the following schedule of reductions used in rolling 14 in. x 32 in. ingots to 29⅞ in. x .125 in. strip, the minimum thickness rolled on the hot mill:

Pass	*Reduction, in.*	*Exit thickness, in.*
Two-high mill		
0	..	14
1	1¼	12¾
2	¾	12
3	¾	11¼
4	¾	10½
5	¾	9¾
6	¾	9
7	¾	8¼
8	¾	7½
9	¾	6¾
10	¾	6
11	¾	5¼
12	⅝	4⅝
13	½	4⅛
14	½	3⅝
15	½	3⅛
16	⅜	2¾
17	⅜	2⅜
18	5/16	2 1/16
19	5/16	1¾
20	5/16	1 7/16
21	¼	1 3/16
22	3/16	1
23	3/16	13/16
24	3/16	⅝
25	⅛	½
Four-high mill		
0	..	.500
1	.150	.350
2	.090	.260
3	.060	.200
4	.055	.145
5	.020	.125

After the first pass in the four-high mill, the strip material is coiled up in one of the coiling furnaces after each pass, retaining its heat so that it may be finished at sufficiently high temperatures.

When producing heavier material, the breakdown is sent to the four-high mill at greater thicknesses, as illustrated in Table I.

Rolling rates on the hot mill average about 35 tons per hr on coiled stock, and about 25 tons per hr on plates.

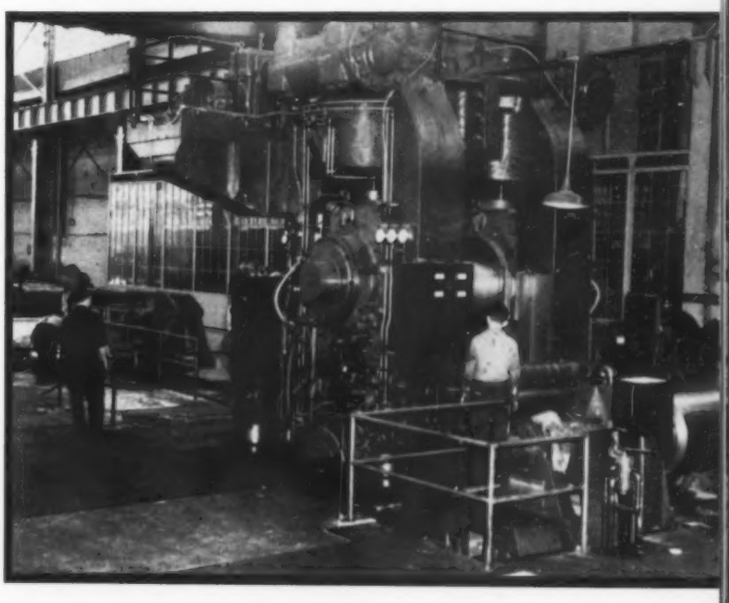
Product is delivered from the four-high mill at speeds up to 655 fpm, and proceeds in one of three courses. Universal plate may be taken from the mill line over a chain type cooling bed about 95 ft wide to a parallel

ANDREW TAYLOR

Chief Electrician

cooling table about 40 ft distant. Universal plate straightening blocks, plate turnover, and chain lifts are incorporated in this bed. The parallel table is approximately 250 ft long, and contains a 40 in. shear and a roller leveler. An alternate course, for sheared plate, is to proceed along the mill table, through a roller leveler about 240 ft from the four-high mill, and on 225 ft farther to an 84 in. x 1¼ in. end shear. Immediately

A temper mill, with separate tension devices on both sides, was recently installed and averages about 11½ tons per hr production.



following the shear is a gravity transfer about 20 ft wide and extending to the right about 30 ft into an adjacent plate finishing department. To the left of the table is a castor bed and two 132 in. x 1½ in. side shears.

Stock intended for coiling proceeds down the mill line to a three-roll up-coiler, which is driven by a 40 hp, 400-1600 rpm, 230 volt d-c motor. The coiler is placed about 155 ft from the four-high mill, and forms coils up to 48 in. in diameter and 42 in. in width, at speeds of 490-600 fpm. A gravity hot coil conveyor approximately 80 ft long carries the hot rolled coils into the pickling department.

The hot mill is housed in a building 832 ft long x 63 ft 9 in. wide.

From the end of the hot mill runout the transfer previously mentioned carries the plate into the adjacent plate finishing building, where complete facilities for

Table I

Ingot size, in.	Finished plate size	No. of passes in 2-high mill	Plate thickness between 2-high and 4-high mills, in.	No. of passes in 4-high mill
12x31x37	¼″x72″x40′	19	1 3/16	11
9x53x33	¼″x48″x70′	14	1¼	10
12x42x40	⅜″x72″x40′	21	1¼	9
20x40x40	¾″x72″x30′	35	2⅜	12

cutting to shape, heat treating, and straightening are installed. Heat treating equipment includes three annealing furnaces, two large and five small hardening furnaces, and three drawing furnaces. Water and oil quenching tanks are available. Additional furnaces under construction include one draw furnace, one continuous hardening furnace, and one continuous hardening and drawing furnace. A 750 ton straightening press, shears, oxyacetylene cutting equipment, roller levelers, cooling racks, inspection tables, etc., are also provided.

Cold Mills and Finishing Departments

For any gauges lighter than .125 in., reduction is performed in reversing cold mills. Prior to cold rolling, the hot rolled coils are taken to the pickling department. A single continuous line is installed, consisting, successively, of a cone type pay-off, scale breaker, roller leveler, spot welder, pinch rolls, water loop tank, pinch rolls, two 45 ft pickling tanks, one 60 ft pickling tank, a 20 ft cold water tank of wooden construction, a power scrubber, an 18 ft steel hot water tank, a hot air blast dryer, pinch rolls, an oiler, and a recoiler. The solution tanks are of steel construction, and lined with rubber and brick. These tanks are 4 ft 7 in. inside width and 3 ft 10 in. deep. Pickling solutions average 10-12 per cent sulphuric acid content, and are held at a temperature of 190 F by steam under automatic control. Speed of material through the pickling line ranges 30-90 fpm.

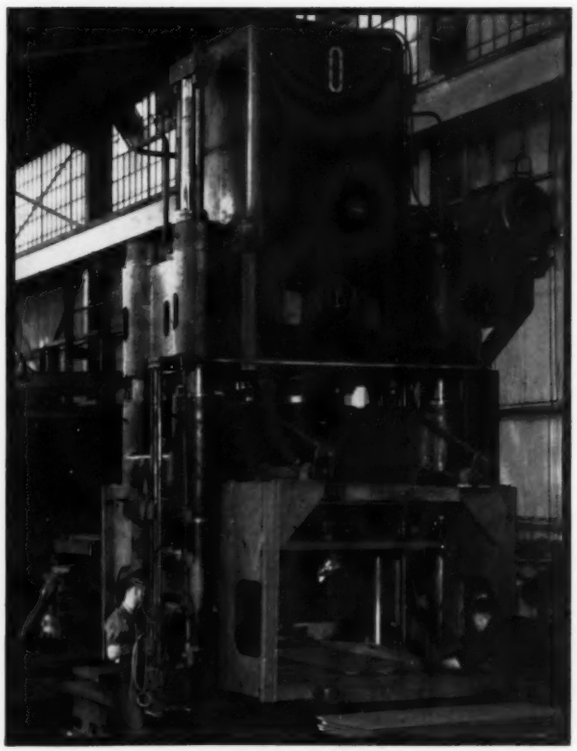
One cold mill is a 16 in. and 43 in. x 42 in. reversing unit, driven by a 1500 hp, 250-560 rpm, 600 volt d-c motor through a reduction gear unit of 2.086:1 ratio, giving mill speeds of 120-260 rpm or 502-1,085 fpm. Each reel for this mill is driven through a reduction gear of 6.75:1 ratio, by a 600 hp, 264-960 rpm, 600 volt d-c motor. A motor-generator set, composed of a 1500 kw, 600 volt d-c generator for the main drive motor, a 250 kw, 600 volt d-c generator for the reel motors, a 75 kw booster generator, and a 30 kw exciter, all driven by a 2500 hp, 750 rpm, 13,200 volt synchronous motor. Mill screws, of .400 in. pitch, are driven through reductions of 1004:1 ratio by two 35 hp mill type motors.

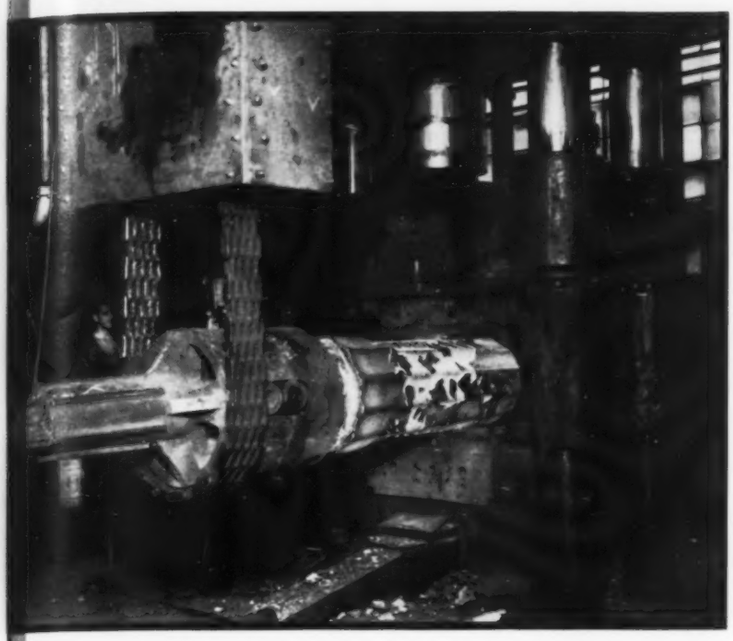
The second cold mill is an 11 in. and 29 in. x 34 in. reversing unit, driven directly at 275-550 rpm, or 792-1584 fpm, by a 1250 hp, 275-550 rpm, 600 volt d-c motor. The reels on this mill are driven at 75-300 rpm by 400 hp, 300-1200 rpm, 600 volt d-c motors. The 34 in. mill receives power from a motor-generator set consisting of four generators, one of 1250 kw, two of 200 kw, and one of 45 kw, driven by a 2000 hp, 750 rpm, 2200 volt synchronous motor. The screws on this mill are of .400 in. pitch, and are driven by two 10 hp motors through reductions with a total ratio of 1012:5. Production rates on the cold mills average about 6½ tons per hr on the 42 in. unit and 4½ tons per hr on the 34 in. stand.

Tin plate material is next put through a continuous electrolytic cleaning line, 116 ft 9 in. long and operating in a speed range of 325-750 fpm. The electrolytic tank receives power from a 48 kw, 8-16 volt, 6000-3000 amp generator driven at 375 rpm by a 75 hp motor.

Sheet annealing facilities include seven rectangular portable annealing covers, 52 in. x 90 in., and one cyl-

View showing an 8000 lb ingot in a 1000 ton press, which is located in the forge department of the plant.





This large straightening press is a recent installation in the plate finishing department.

indrical cover, 54 in. diameter x 90 in. All of these furnaces are heated by coke oven gas burned in vertical radiant tubes. Gas preparation machines provide deoxidizing gas for maintenance of a controlled atmosphere in these furnaces, as well as in a continuous blue annealing furnace installed in the cold mill department.

A recent installation is a four-high, 18 in. and 49 in. x 42 in. temper pass mill, used for a 1-3 per cent temper reduction on tin plate material. Each housing post is 29 in. x 24½ in., and the housing is 25 ft 1¼ in. high and 14 ft 3 in. wide, overall. Housing windows are 55 in. wide x 15 ft 3 in. high. Mill screws are 18 in. diameter and .400 in. pitch, and are driven through a total reduction of 1025:1 ratio by two 35 hp, 575 rpm, 230 volt d-c motors. Work rolls operate in roller bearings, while back-up rolls run in oil film bearings.

Tension roll units are located on both sides of the mill, each roll being separately driven through a spur gear reduction. Entry tension rolls are driven by two 150 hp, 500-1250 rpm, 250 volt d-c motors, while two 225 hp motors of similar characteristics drive the exit tension rolls. The pay-off reel is provided with a 50 kw drag generator, and a 150 hp motor drives the recoiler.

Three motor-generator sets provide power and control for the temper mill. The main set includes one 1000 kw generator and one 600 kw generator, both of 250 volts, and two 50 kw, 32 volt generators, all driven at 750 rpm by a 1700 hp, 2200 volt synchronous motor. A booster generator set is composed of four small generators driven by a 175 hp motor, while a tension regulator set is made up of six small generators driven by a 15 hp motor. This mill averages about 11.5 tons of product per hr.

After temper rolling, coils are put through either of two cutting lines, where flying shears cut the material into the desired length. For tin plate production this black plate is then processed in a white pickler of the vertical plunger type, after which tinning is performed in eight tinning lines.

Four stands of two-high hand mills are available for temper rolling on cut lengths of material. A complete layout of auxiliary finishing equipment is also provided, including shears, slitter, oiler, levelers, branner, upsetter, etc., as well as grinders for roll maintenance.

Plant Services

The entire power supply for the steel plant is purchased at 13,000 volts, 25 cycles, and is stepped down to 2200 volts, in an outdoor substation containing six 1500 kva transformers for plant distribution. Power for the arc furnaces goes direct to the furnace transformers at 13,000 volts. Some 2200 volt, 60 cycle power is also purchased for the foundry plant. The 60-cycle equipment in the hot mill is supplied with power from a frequency converter set composed of a 625 kw, 62½ cycle, 2300 volt generator and a 720 hp, 750 rpm, 25 cycle, 2200 volt motor. General plant d-c power is provided by a 500 kw and a 400 kw motor generator set in the steel plant, in addition to the 600 kw unit on the shaft of the temper mill motor-generator set, and four sets totaling 930 kw in the foundry.

Water is taken from Burlington Bay through a revolving screen and a finer secondary screen by three motor driven centrifugal pumps. City water is used for drinking and for certain special uses. Plant requirements average about 2,000,000 gal per day of bay water and 1,500,000 gal per day from the city supply.

Steam is generated at 165 psi pressure in three oil-fired boilers, of 150, 200, and 318 hp rating, respectively.

Plant fuel is, for the greater part, bunker C fuel oil, brought in by boat and delivered to the plant through a pipe line and by rail. Storage capacity is provided by a 2,800,000 gal tank, two 200,000 gal tanks and two 100,000 gal tanks. Some coke oven gas is also used, being purchased from the nearby coke plant of the Hamilton By-Product Coke Ovens, Ltd.

D. O. DAVIS

OFFICIAL
A. I. S. E. Spring

NOTE: Due to the fact that April 27 has been selected by the Selective Service Board as an official registration day, the A.I.S.E. has deemed it advisable to change the Spring Conference dates to May 11-12, 1942.

Chairman
C. L. McGRANAHAN
Assistant General Superintendent
Jones and Laughlin Steel Corporation
Pittsburgh, Pennsylvania

No formal identification necessary to enter Canada.

Vice Chairman
H. A. WHITE
Vice President and Director
Hamilton Bridge Company, Ltd.
Hamilton, Ontario

Monday, May 11

2:00 P.M. — Inspection trip, Dominion Foundries and Steel, Ltd.

6:30 P.M. — Dinner — Speaker: L. Joslyn Rogers, Chemical Engineer.

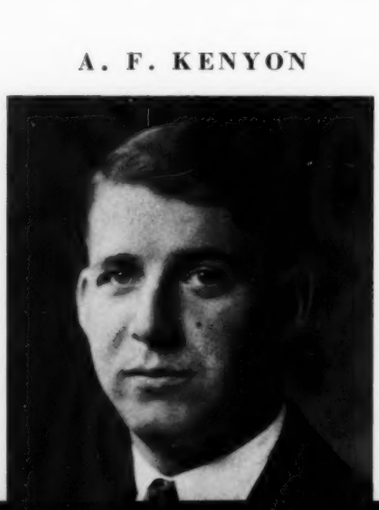
8:00 P.M. — Technical Session

"Flat Rolled Production at Dominion Foundries and Steel, Ltd." by D. O. Davis, Superintendent of Maintenance, Dominion Foundries and Steel, Ltd., Hamilton, Ontario

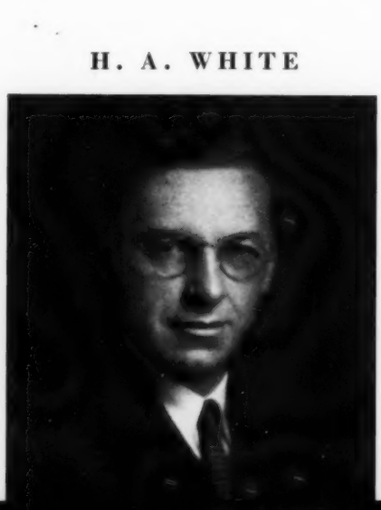
"Plate Mill Drives and Power Requirements," by C. J. Porter, Electrical Engineer, Steel Company of Canada, Ltd., Hamilton, Ontario; C. A. Price, Chief Engineer, Canadian Westinghouse Company, Ltd., Hamilton, Ontario; and A. F. Kenyon, Steel Mill Engineer, Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pennsylvania

L. McGRANAHAN

A. F. KENYON



H. A. WHITE



A. J. FISHER

PROGRAM
Conference

PLEASE MAKE
RESERVATIONS EARLY

C. J. PORTER

Chairman
C. J. PORTER
Electrical Engineer
Steel Company of Canada, Ltd.
Hamilton, Ontario

ROYAL CONNAUGHT HOTEL
Hamilton, Ontario

Vice Chairman
A. J. FISHER
Fuel Engineer
Bethlehem Steel Company
Sparrows Point, Maryland

Tuesday, May 12

9:00 A.M. — Technical Session

"Fuel Rate Control Systems for Regenerative Furnaces," by J. R. Green, Brown Instrument Company, Pittsburgh, Pennsylvania

"Developments in Non-Ferrous Bearing Metals," by H. A. White, National Bearing Metal Company, Pittsburgh, Pennsylvania

"Steel Plant Lighting in Wartime," by J. P. Ditchman, General Electric Company, Nela Park, Cleveland, Ohio

2:00 P.M. — Inspection trip, Steel Company of Canada, Ltd.

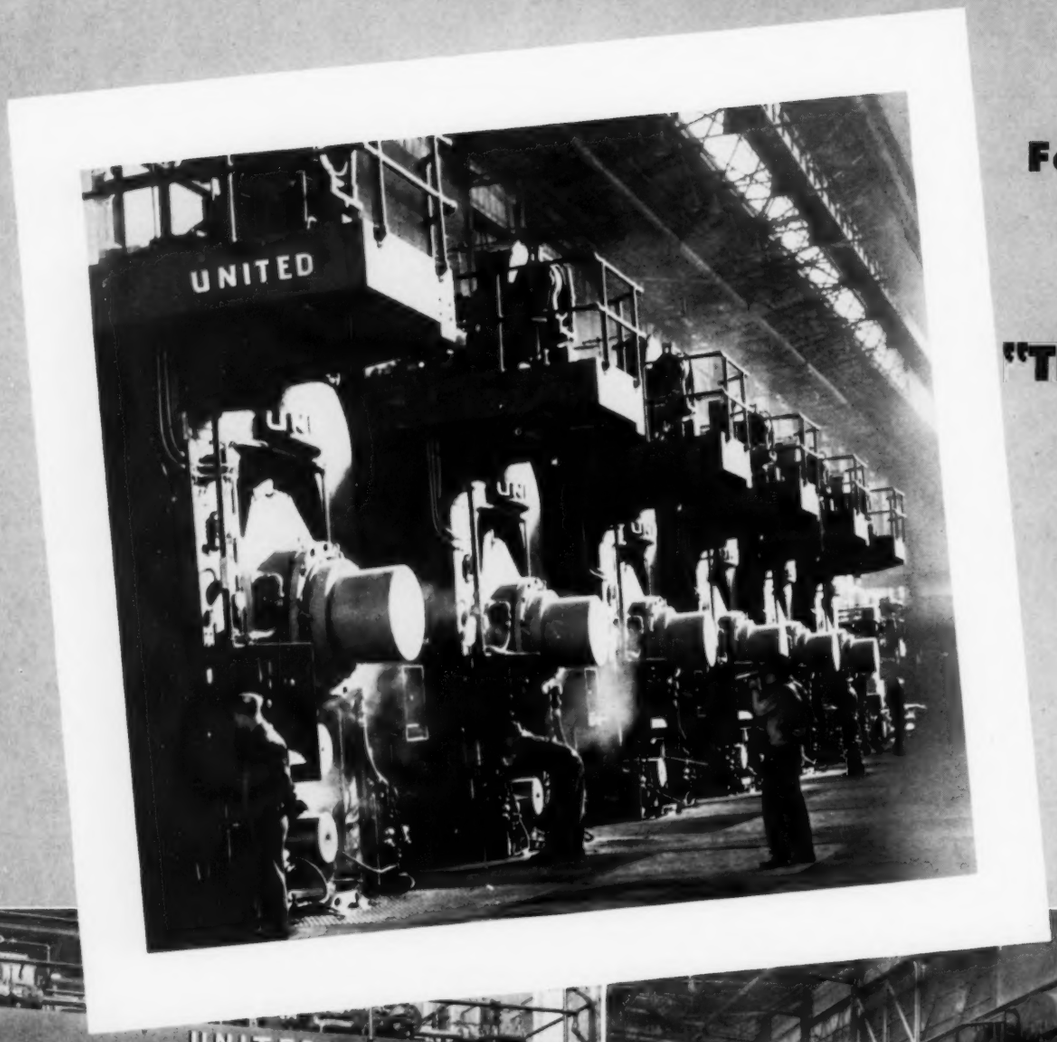
J. R. GREEN

J. P. DITCHMAN

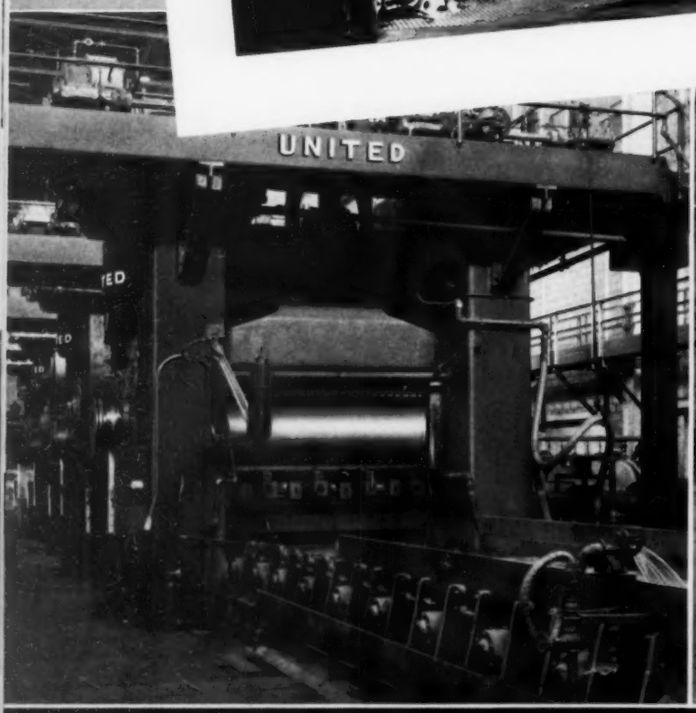
C. A. PRICE

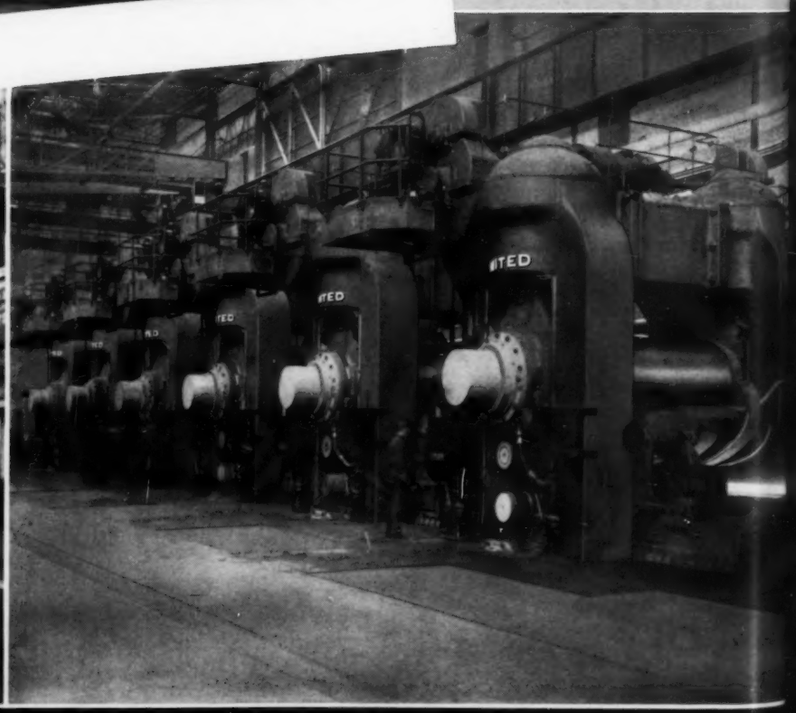
C. CLARKE WALI

UNITED



For all metals in all sizes up to "THE WORLD'S" LARGEST

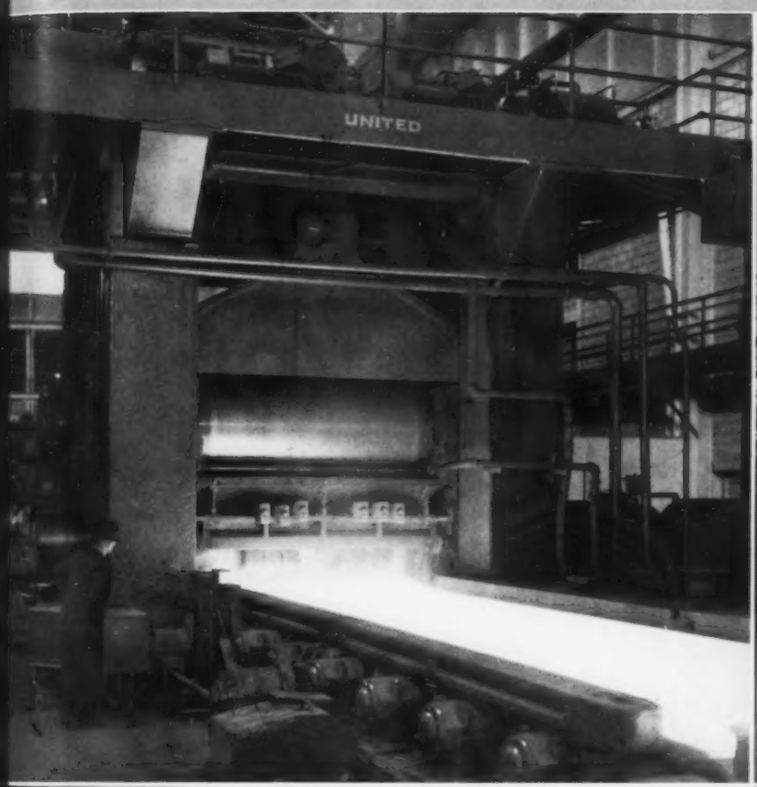


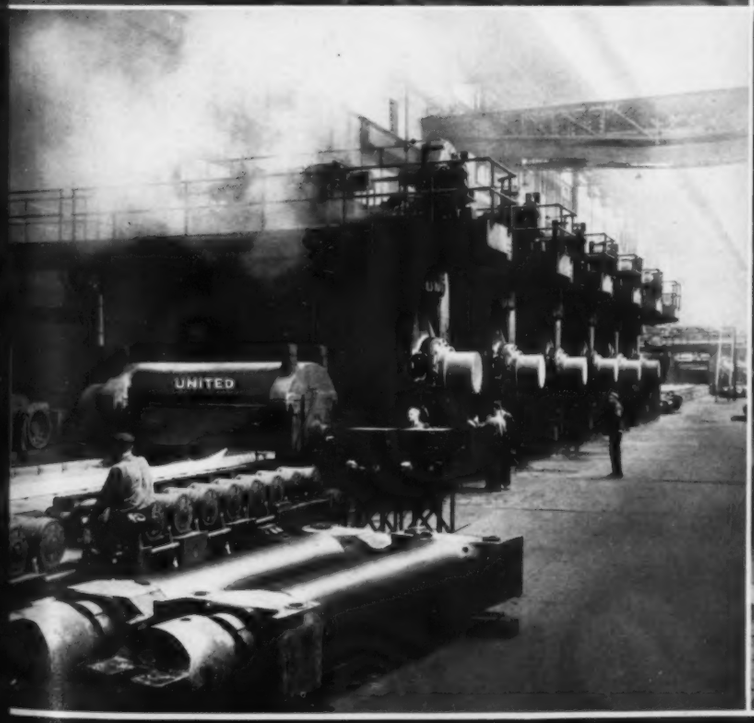


UNITED ENGINEERING *and* FOUNDRY COMPANY

Pittsburgh, Pennsylvania

HOT STRIP, SHEET AND PLATE MILLS



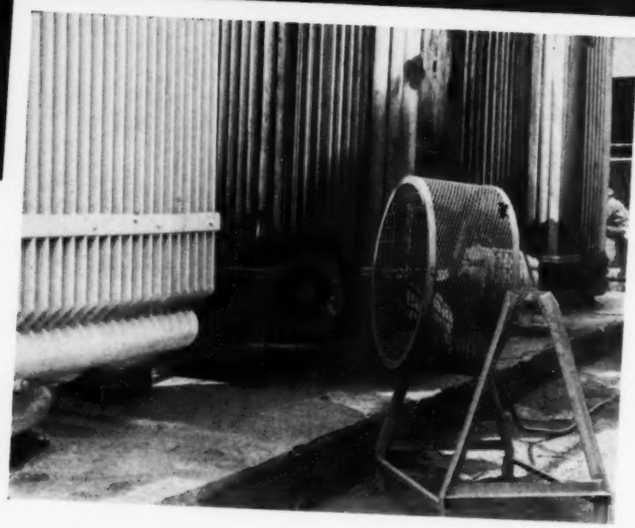


DAVY AND UNITED ENGINEERING COMPANY, LTD., SHEFFIELD, ENGLAND · DOMINION ENGINEERING WORKS, LTD., MONTREAL, P. Q. · UNITED INTERNATIONAL, S. A. PARIS, FRANCE ·

Let Truflo Fans . . .

Help keep your workmen on their toes

Portable Fan No. TF-100, recognized as standard in many of the country's largest mills. Sizes from 12 in. to 36 in. in diameter.



Portable Fan No. TF-300 in operation, cooling large condensers in strip mill.

Crane Cab Fan, for cooling crane cab interiors and other confined areas. Available in 12 in. and 18 in. sizes, adjustable both horizontally and vertically.

Portable Fan No. TF-300W. Angle iron support adjusts for vertical or horizontal discharge through almost 360°.

It's more important now than ever before to keep your workmen comfortable. For comfortable workmen are more efficient, produce more work in a given time.

Truflo Fans can help you keep your workmen on their toes. All Truflo Fans are designed and built correctly for efficient, economical operation — they move more air per dollar. Write for free literature on any of the following styles:

Portable Cooling Fans • Crane Cab Fans
Wall Fans • Exhaust Fans • Blowers
Roof Ventilating Fans • Pent House Fans

TRUFLO FAN COMPANY

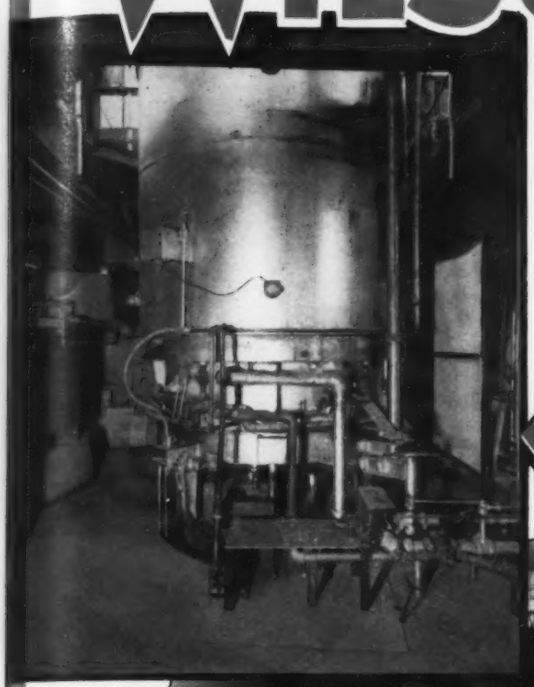
554 MAIN STREET HARMONY, PA.

WILSON

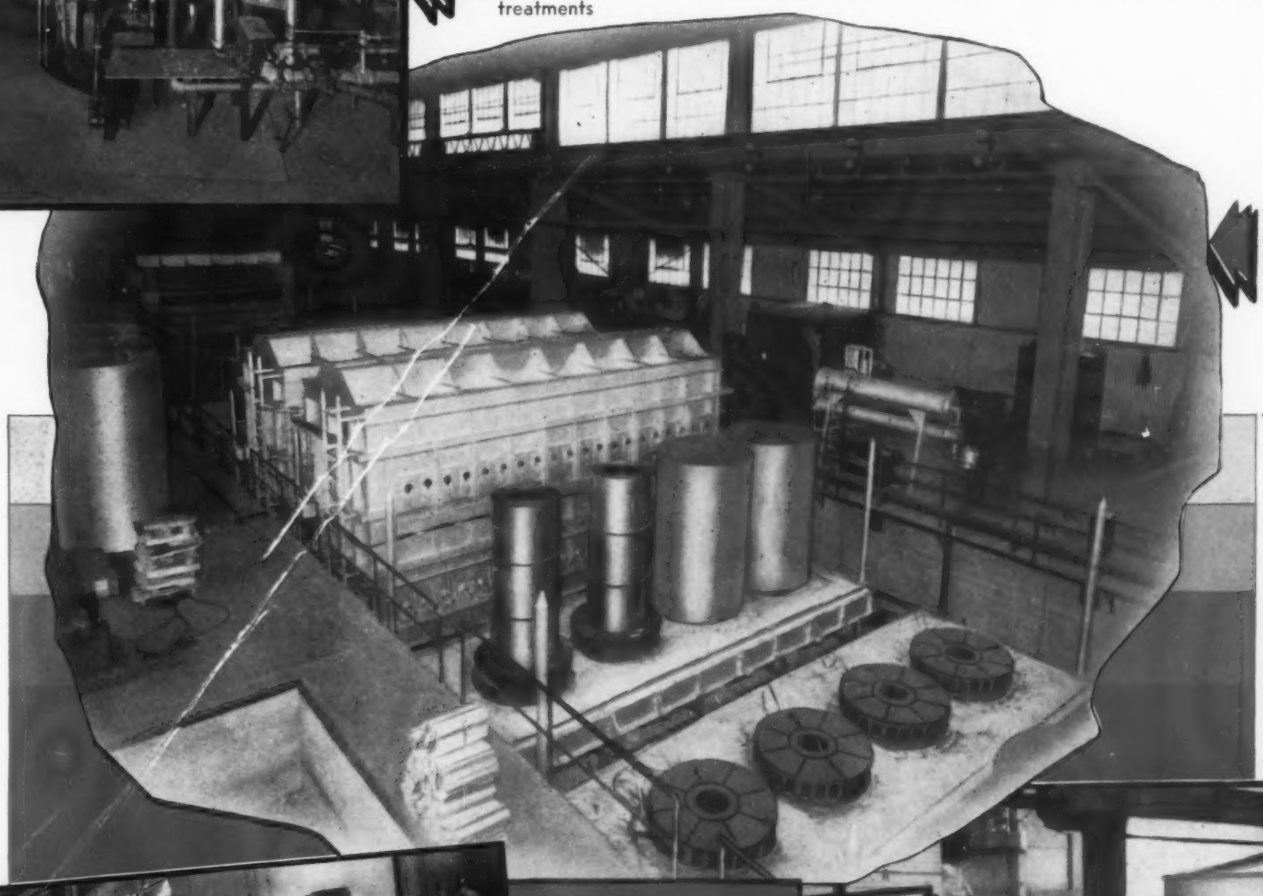
RADIANT TUBE • BELL TYPE ANNEALERS *in* CANADIAN PLANTS

Help SPEED UP *Canada's* WAR EFFORT

THE Lee Wilson Engineering Company also builds Shell Heat Treating Lines, Continuous Gun Barrel Heat Treating Equipment, Armor Plate Car Furnaces, and all types of Radiant Tube Atmosphere Control Furnaces.



Wilson firing retort bell furnace for special rod treatments



Two four-stack plate annealers this plant

Firing retort furnace for single stack tin plate coils 54" diam. x 90" chg.

One of two wire annealing units—four bases each

LEE WILSON ENGINEERING CO.

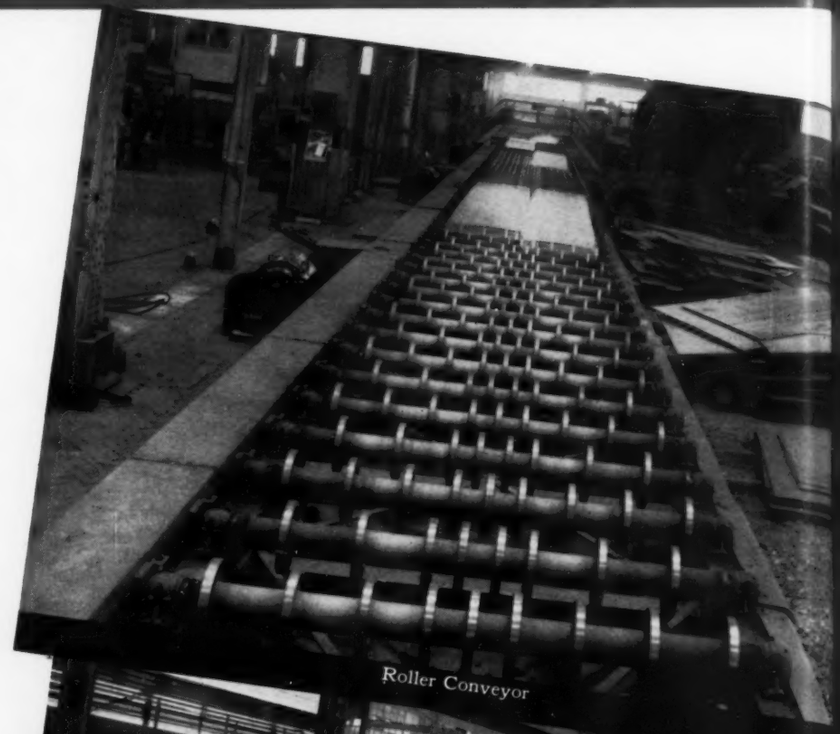
1370 BLOUNT ST. CLEVELAND, OHIO

TREADWELL

At the Largest Steel Company in Canada

In the building of Rolling Mill Equipment, Treadwell aims toward those principles of design and construction that aid most in assuring the user increased production, continuous production and production at lowest cost.

Treadwell has the facilities—plant equipment and personnel—and a vast amount of experience building Rolling Mill Equipment. You can depend on Treadwell Engineers to interpret accurately your individual requirements.



Roller Conveyor

Slab and Bloom Transfer

Plate Transfer with Runout Table

Cold Rolling Mills

Tables and Transfers

Cooling Beds

Coilers—Hot and Cold Strip

Merchant Mills

Special Machinery

Steel and Iron Castings

Treadwell Engineering Company
Easton, Pennsylvania

★ ★ ★ ★ ★ ★

IT'S A

DREVER ROLLER HEARTH LINE

FOR ARMOR PLATE

Continuous production of quality armor plate in one integrated line of furnaces, at high production rates.

THE DREVER COMPANY
770 EAST VENANGO STREET, PHILADELPHIA, PA.

AT DOMINION FOUNDRIES

EXPERIENCE POINTS TO THE DREVER CO.

Leading CANADIAN STEEL MILLS *are using* TRADE AUTOMATIC MARK FORK TRUCKS *for* Greatest Flexibility and Modern Low-Cost Sheet and Tin-Plate Handling Operations

6000-lb. capacity telescopic — tilting — tiering center-control "AUTOMATIC" Fork Truck stacking unit loads of packaged tin plate 8 high.

3000-lb. capacity non-telescopic — tilting — tiering rear-control "AUTOMATIC" Fork Truck operating efficiently for car loading operation.

Heavy-Duty 10,000-lb. capacity "AUTOMATIC" Fork Truck placing Bosh tanks in tilted position at machines.

One of a fleet at a leading steel mill. "AUTOMATIC" 3000-lb. capacity rear-control telescopic tilting — tiering Fork Truck used for miscellaneous handling and box car loading and unloading.

AUTOMATIC TRANSPORTATION CO.

DIV. OF THE YALE & TOWNE MFG. CO.

47 W. 87th Street — Chicago, Illinois

☆

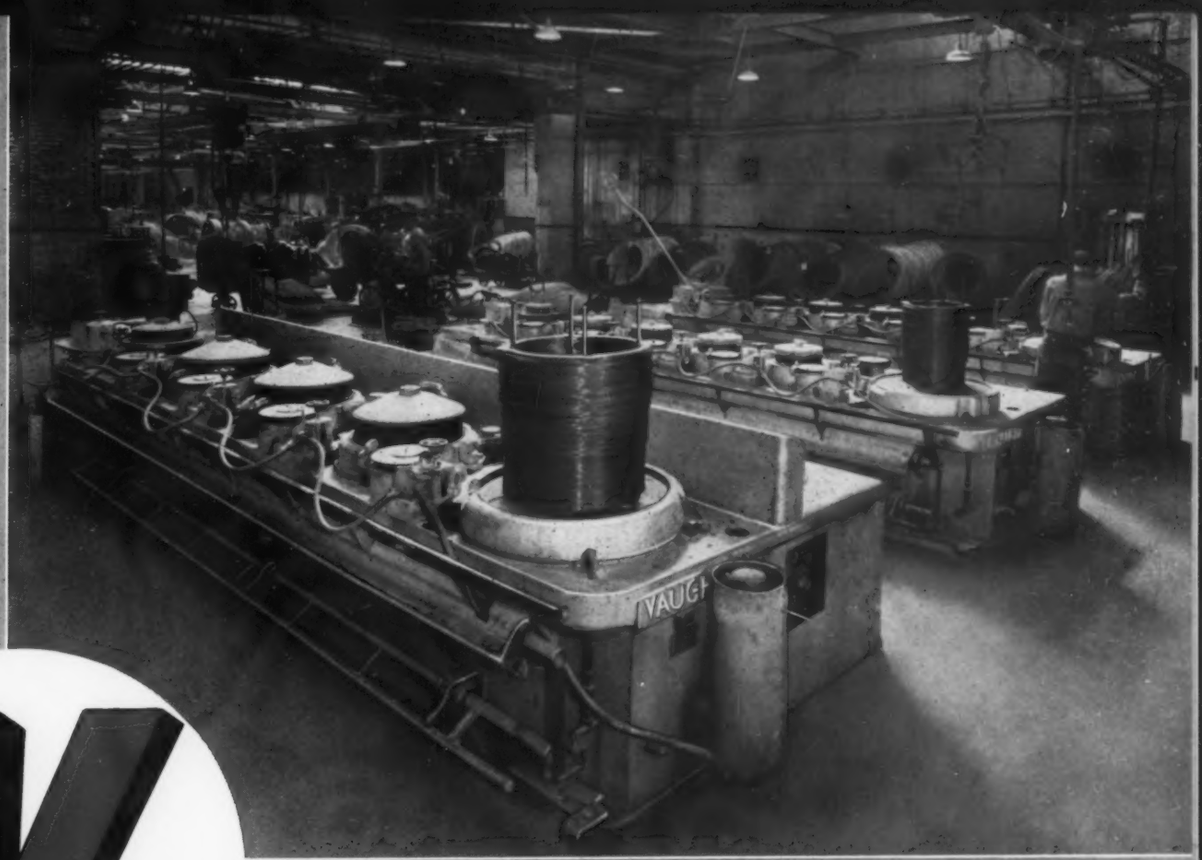
Canadian "AUTOMATIC" *Representative*

H. C. BURTON AND COMPANY

Offices — 166 REBECCA ST., HAMILTON, ONTARIO
76 WELLINGTON ST., TORONTO ONTARIO

☆

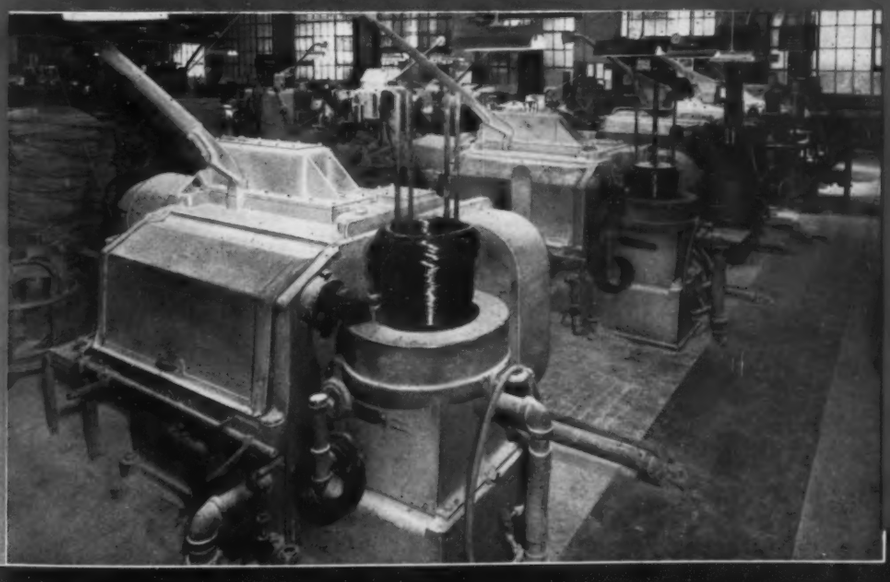
WHEN YOU BUY TRUCKS . . *Ask* "AUTOMATIC"



VAUGHN

WIRE DRAWING MACHINERY

Speeds wire production where every minute counts!



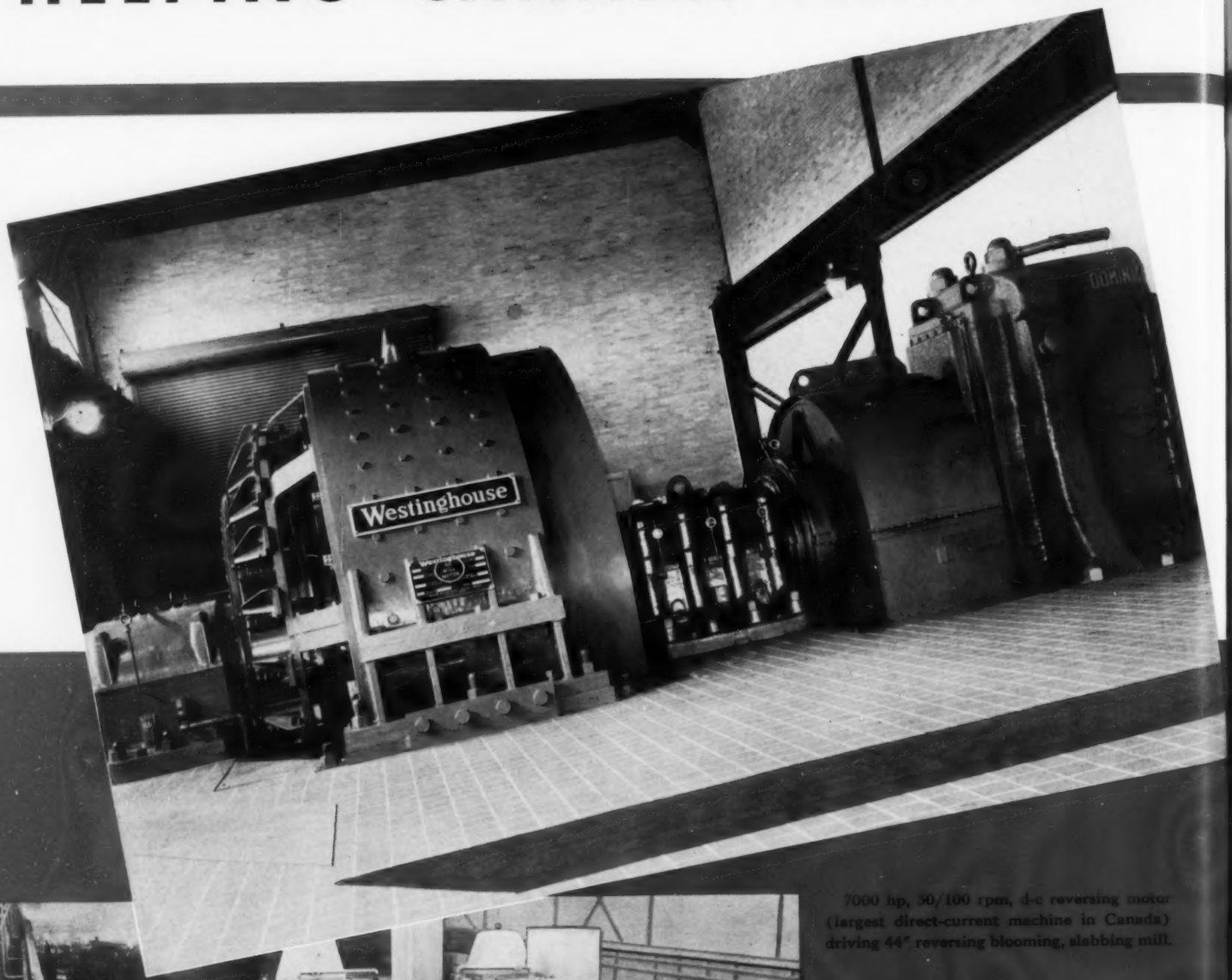
THE great share of Canada's industrial Victory effort borne by the Dominion's largest steel company requires maximum speed and dependability in every production unit—demands met in full by the Vaughn Wire Drawing machinery serving this producer • Vaughn performance can benefit *your* tough schedules. Write for the facts.

THE VAUGHN MACHINERY CO.

CUYAHOGA FALLS, OHIO, U. S. A.

Complete Cold Drawing Equipment . . . Continuous or Single Hole . . . For the Largest Bars and Tubes . . . For the Smallest Wire . . . Ferrous, Non-Ferrous Materials or their Alloys

HELPING CANADA PRODUCE



7000 hp, 50/100 rpm, d-c reversing motor (largest direct-current machine in Canada) driving 44" reversing blooming, slabbing mill.

44" reversing blooming, slabbing mill, driven by Westinghouse 7000 hp motor.

Westinghouse

MORE STEEL

In 1913 Westinghouse furnished the electrical drive for the first reversing blooming mill in Canada. This mill is still in regular operation helping to produce the enormous quantities of steel so vital to our United Nations' victory. Since the installation of this mill, Westinghouse has continued to enjoy a leading position as supplier of rolling mill drive equipment for Canadian mills.

But victory calls for *more steel*—more Blooming, Slabbing and Plate Mills are needed. More rolling capacity is required.

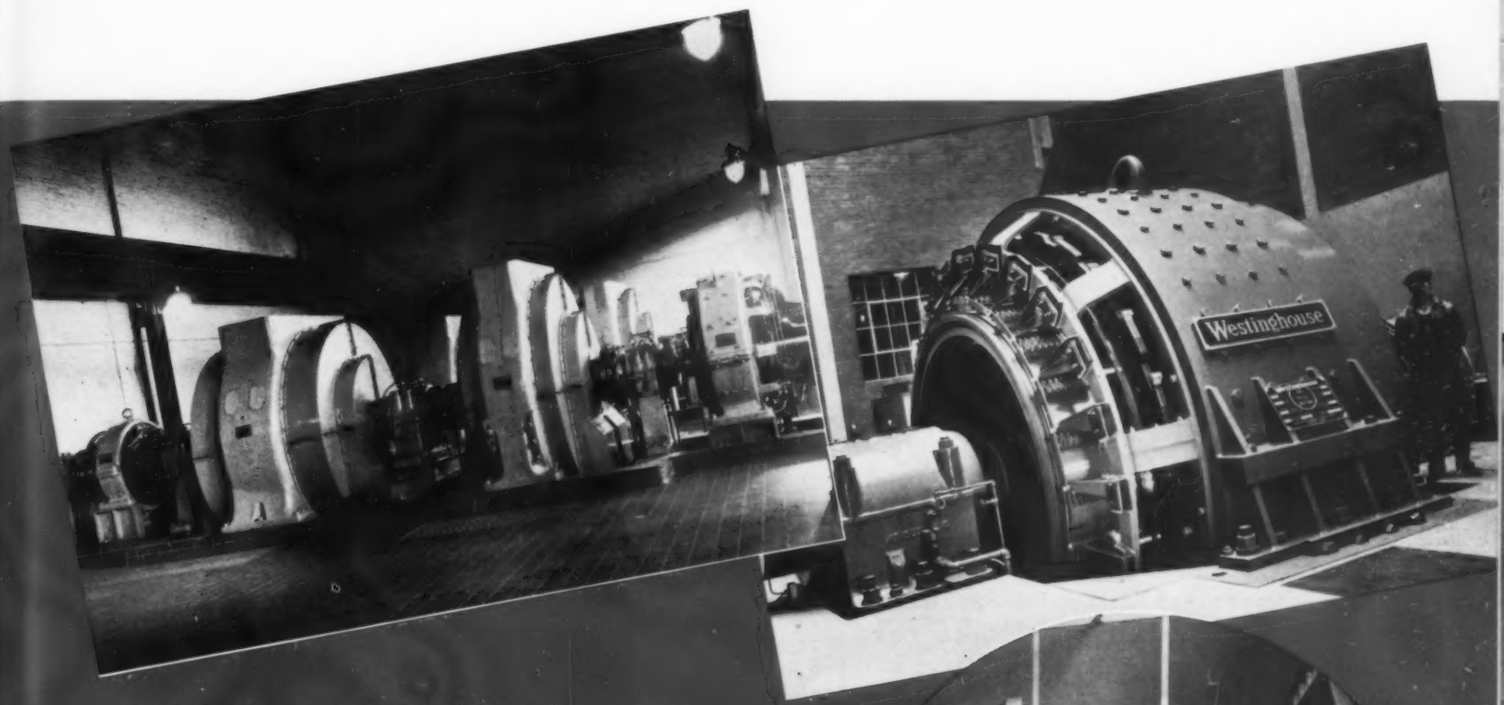
Westinghouse is ready to meet this urgent demand. Ready by virtue of our experience as leading supplier of heavy mill drive equipment.

Canadian Westinghouse Company, Limited,
Hamilton, Ontario

Co-ordinator in design and engineering with

Westinghouse Electric & Mfg. Company,
East Pittsburgh, Pa.

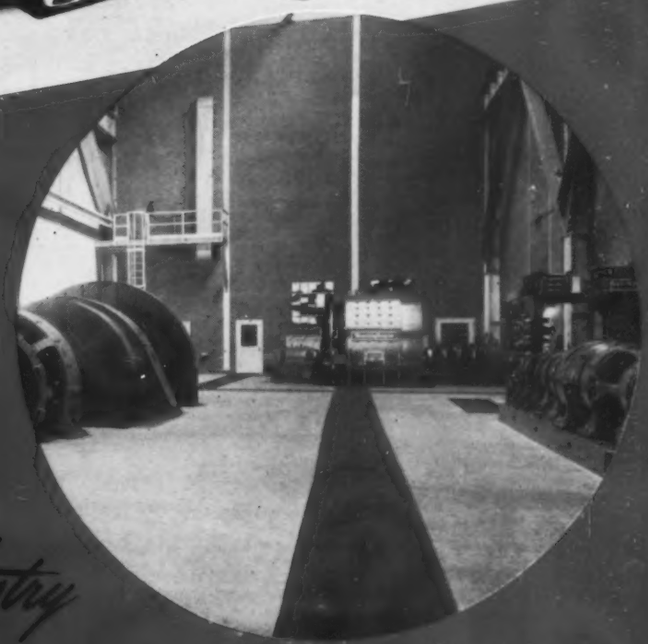
J-94498



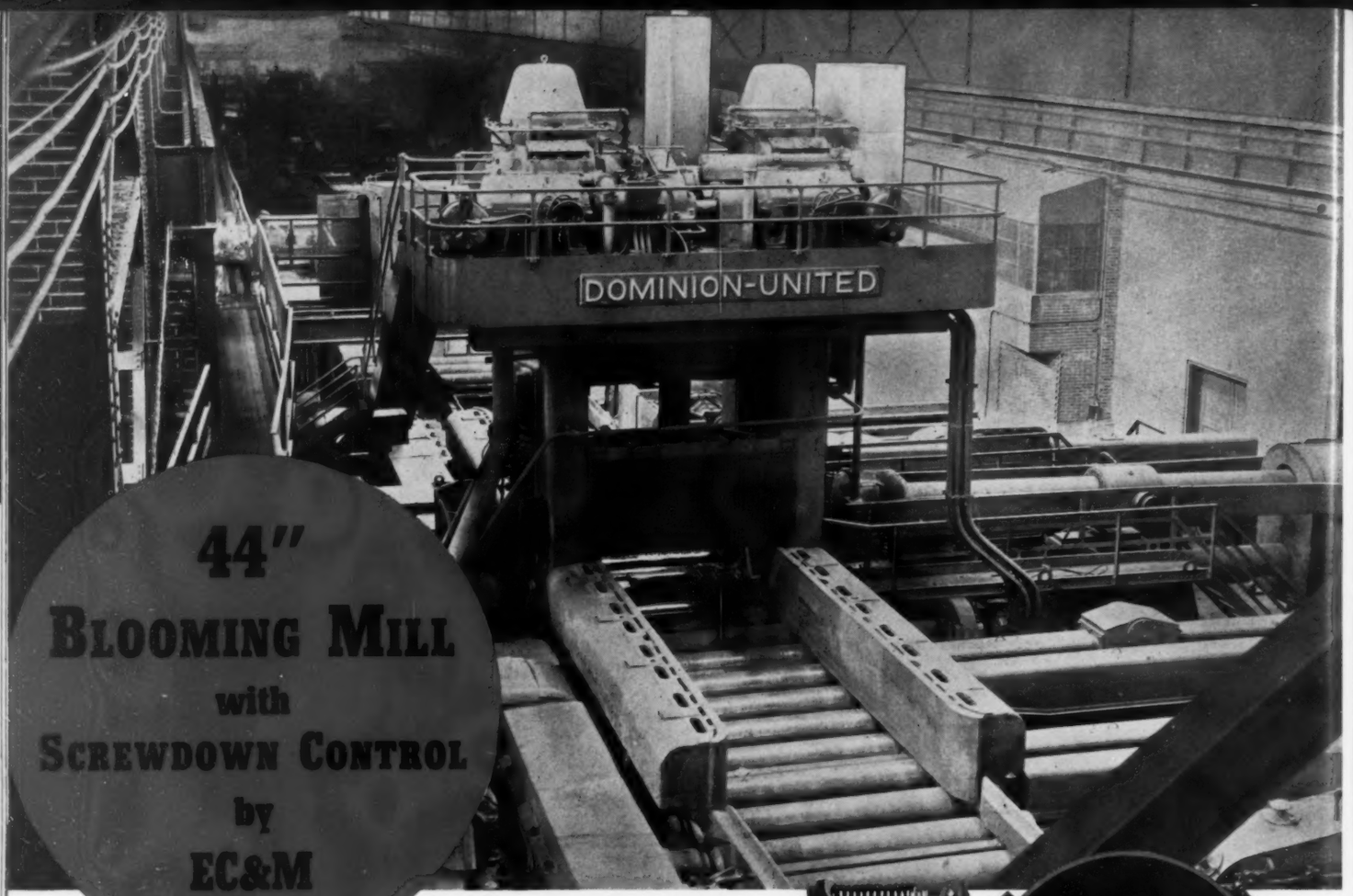
(Upper left) Two Westinghouse, 3500 kv-a frequency changer sets tie together the 25 cycle and 66⅔ cycle systems in a large Canadian steel plant, also supply 250 v and 125 v d-c for auxiliary power and excitation requirements.

(Upper right) This 5000 hp 35/80 rpm reversing motor drives a new 110" plate mill.

(Lower right) 110" plate mill motor room, showing 5000 kw flywheel motor generator set, 5000 hp main reversing motor, and exciter and control equipment.



Time saver for the Steel Industry



44" Blooming Mill with Screwdown Control by EC&M

This screwdown drive is equipped with an automatic positioner, designed and built by the electrical department of this steel mill, by means of which the operator sets up for the next pass while the steel is going through the mill.

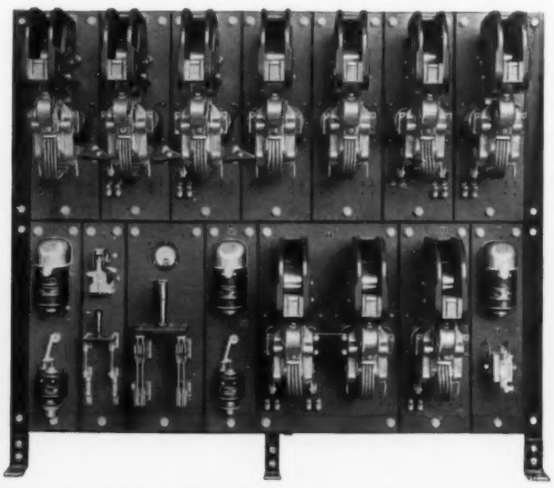
EC&M Type WB Brakes and EC&M LINE-ARC Magnetic Contactor Control are a good combination for the screwdown motors of a blooming mill because they are exceptionally fast-operating and have many exclusive features which insure low maintenance.

Bulletin 1004-C Type WB Brakes, for example, are designed with thick brake block linings (3/4" thick on the size used on these screwdown motors) . . . all bearing pins are oversize and are case-hardened . . . bushings are of Nitralloy Steel . . . there is only one adjustment to compensate for wear . . . there are no rods, levers or other parts of the brake passing over the top of the wheel.

With the Bulletin 921 LINE-ARC Magnetic Contactor Controller, the arc as the circuit is ruptured, is scientifically controlled by the LINE-ARC principle . . . contacts have long life because they remain cool under this method of operation. Arc shields are protected from destructive burning. Acceleration relays are of the TIME-CURRENT Type which automatically regulate acceleration of the motor according to load. Fast acceleration occurs on light loads . . . longer time is automatically provided for heavier loads.

For efficient, economical service, equip your direct current drives with EC&M Type WB Brakes and EC&M LINE-ARC Magnetic Contactor Control.

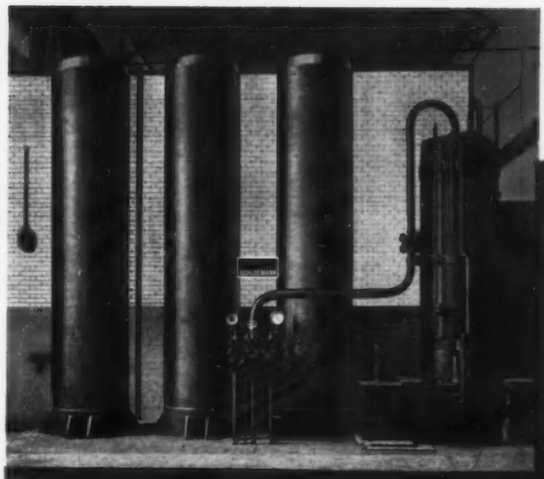
On each screwdown-motor-shaft is mounted a Bulletin 1004-C Type WB Brake. Manipulator-finger and Sideguard motors are also equipped with WB Brakes.



Typical EC&M *LINE-ARC* Magnetic Contactor Controller for Blooming Mill Screwdown service. Main Table, Feed Rolls, Manipulator Fingers, Sideguards and Approach Table on this mill also operated by EC&M *LINE-ARC* Controllers.

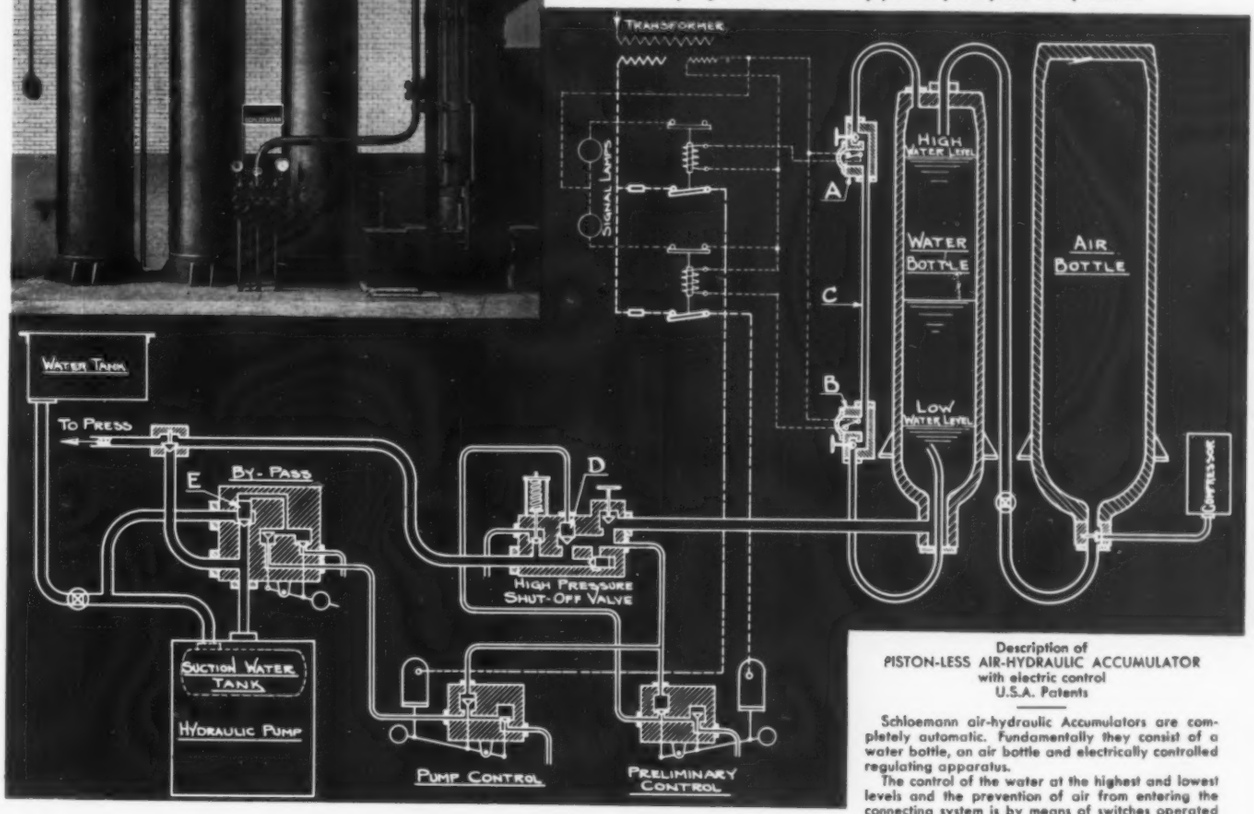
THE ELECTRIC CONTROLLER & MFG. CO. E&M CLEVELAND, OHIO

HEAVY DUTY MOTOR CONTROL FOR CRANES, MILL DRIVES AND MACHINERY • BRAKES • LIMIT STOPS • LIFTING MAGNETS AND AUTOMATIC WELD TIMERS.



Accumulators furnished in sizes from fifty gallons to twenty-five hundred gallons and for pressures up to forty-five hundred pounds per square inch.

System shown at left has two hundred gallons capacity and is designed for twenty-eight hundred and fifty pounds per square inch pressure.



Description of
PISTON-LESS AIR-HYDRAULIC ACCUMULATOR
with electric control
U.S.A. Patents

Schloemann air-hydraulic Accumulators are completely automatic. Fundamentally they consist of a water bottle, an air bottle and electrically controlled regulating apparatus.

The control of the water at the highest and lowest levels and the prevention of air from entering the connecting system is by means of switches operated by floats contained in chambers of a communicating tube "C." Thus the switch "A" in the upper chamber controls the operation of the hydraulic pump, while that in the lower chamber "B" controls the check valve "D" which shuts off the accumulator at lower water level.

The continuous running pump is controlled by closing the By-Pass check valve "E" by means of the pump control, causing it to idle by opening the same and returning the water to the suction end. Over-pressure is released through safety valves and is indicated by an alarm.

SCHLOEMANN

AIR-HYDRAULIC ACCUMULATORS

HYDRAULIC EXTRUSION PRESSES

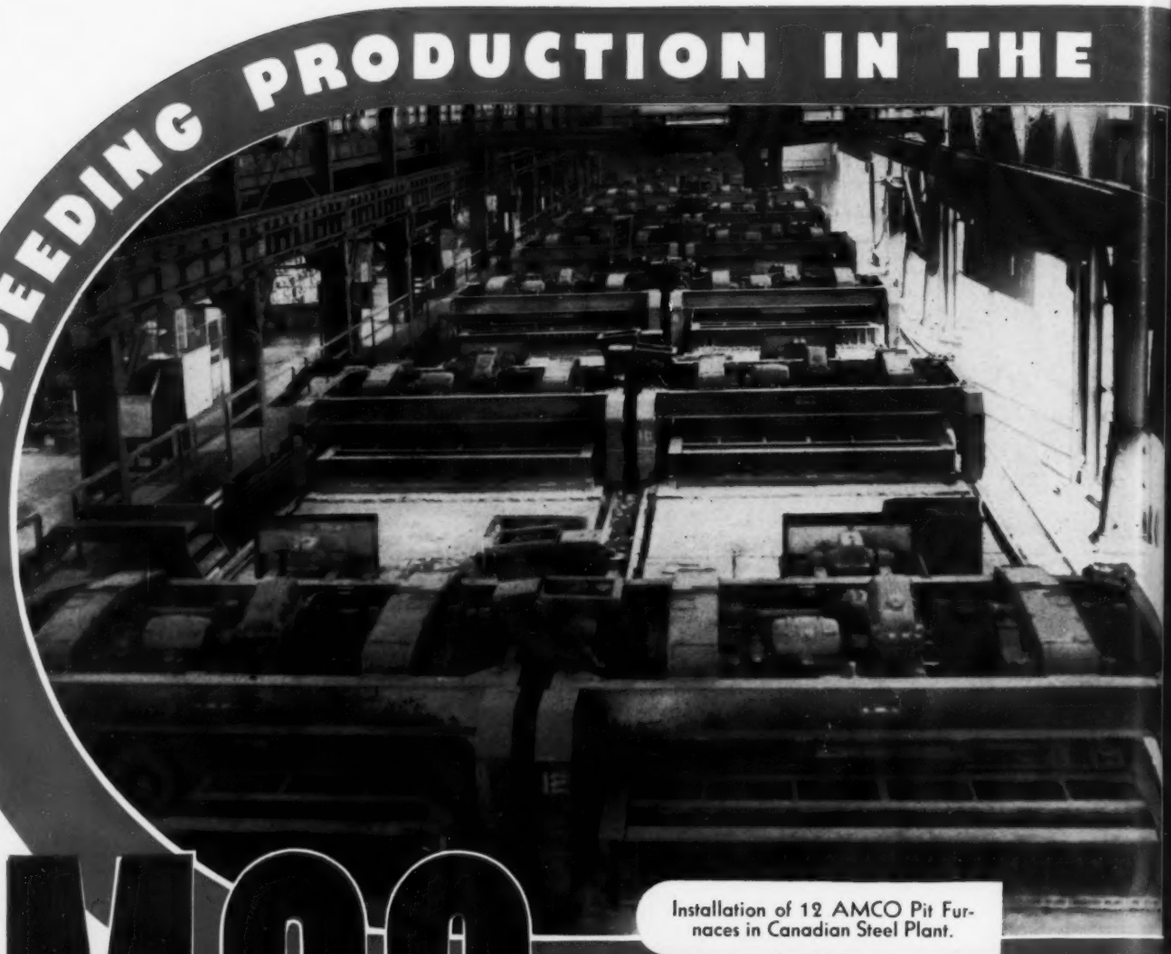
HIGH PRESSURE PUMPS

COMPLETE HYDRAULIC SYSTEMS

ENGINEERING CORP. — Rolling Mill Machinery

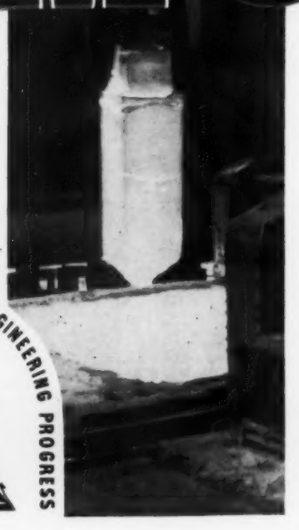
PITTSBURGH, PA. — Hydraulic Presses

. . . SPEEDING PRODUCTION IN THE



Installation of 12 AMCO Pit Furnaces in Canadian Steel Plant.

AMCO FURNACES



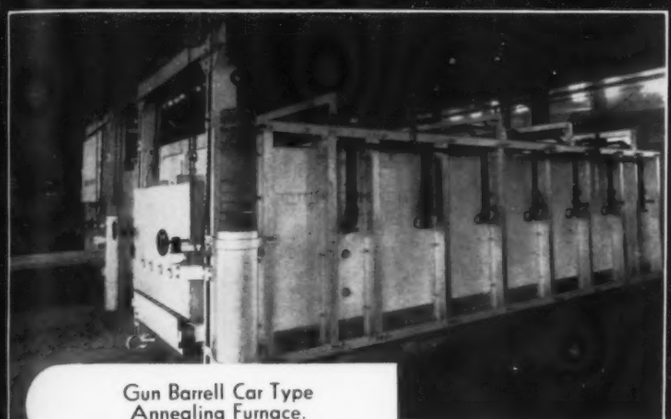
- **Continuous Heating Furnaces**
- **Amco Pit Furnaces**
- **Rotary Hearth Furnaces**
- **Forging Furnaces**
- **Annealing Furnaces**
- **Pulverized Coal Systems**

OVER A QUARTER-CENTURY OF ENGINEERING PROGRESS

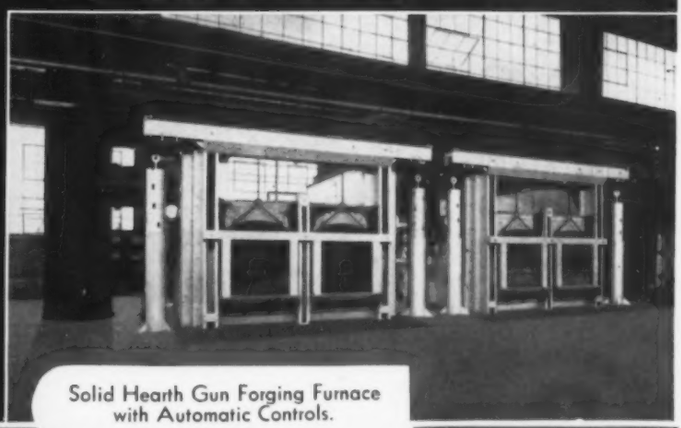
UNITED STATES AND CANADA

Continuous Charging-End Fired Slab Heating Furnace combined with Recuperator.

Heavy Duty Forge Furnace fired with Pulverized Coal Automatically Controlled.



Gun Barrell Car Type Annealing Furnace.



Solid Hearth Gun Forging Furnace with Automatic Controls.

and EQUIPMENT

AMCO engineers are continually introducing improved methods to increase production, decrease fuel consumption and effect greater economies. Such methods are represented by the development of Furnaces and Equipment that are recognized as distinct advances in the technology of conservation of heat and its application to metals. AMCO Furnaces are equipped with automatic controls, which have been applied to all kinds of furnaces and fuels including pulverized coal.

The AMSLER-MORTON Company

FULTON BUILDING · PITTSBURGH, PA.

1 of 7 SWINDELL

CAR-BOTTOM FURNACES

at "DOMINION" with 5 more under way!

THE battery of seven SWINDELL Car-Bottom Furnaces now serving Dominion Foundries and Steel Company, Ltd., is soon to be augmented by five additional units—providing an impressive total of modern heat treating capacity. These furnaces are handling armor-plate and castings with uniform precision *under positive heat control.*

We would be glad to show you how SWINDELL Furnaces can help solve your own war production problems—*this year.*

SWINDELL-DRESSLER *Corporation*

DESIGNERS AND BUILDERS OF MODERN INDUSTRIAL FURNACES

PITTSBURGH, PENNSYLVANIA

EFFECTIVE SAFEGUARDS *Against Costly Fuel Waste*

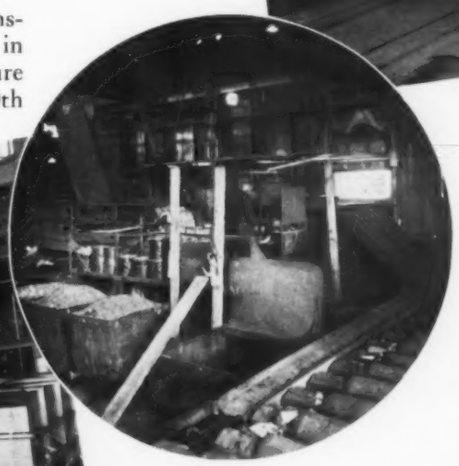
Amsler-Morton Forge Furnaces. Insulations applied here include Sil-O-Cel C-22 Brick, Sil-O-Cel Super Brick and Superex Block. HT (High Temperature) Firecrete used for door linings.

Johns-Manville Insulations minimize heat losses at Dominion Foundries and Steel, Ltd.

To meet a wide variety of service conditions in this Canadian mill, Johns-Manville Insulating Materials were specified. Many different J-M Insulations are used . . . in brick, block, pipe-covering and cement form. Each is designed for a particular operating requirement. In the services for which they are designed, all deliver the long life and high efficiency that mean maximum fuel savings.

For details on the complete line of Johns-Manville Insulations, see our listing in Sweet's Catalog, or write for brochure IN-55A. Johns-Manville, 22 East 40th Street, New York, N. Y.

↑ Amsler-Morton Car Type Annealing Furnaces. Sidewalls insulated with Sil-O-Cel C-22 Brick backed up with Superex Block. Roof of same materials plus 1" J-M No. 500 Cement.



← Amsler-Morton Billet Heating Furnace. Insulated with Sil-O-Cel C-22 Brick, JM-20 Brick and Superex Blocks. LW (Light Weight) Firecrete used for door linings.

← Swindell-Dressler Car Type Annealing Furnaces at Dominion Foundries and Steel, Ltd. Used here as insulation are JM-20 Brick and Superex Block. Doors are lined with LW (Light Weight) Firecrete.

Johns-Manville INDUSTRIAL INSULATIONS

For every service . . . for every temperature

A 50 ton MOORE RAPID *Lectromelt* FURNACE at Dominion Foundries and Steel, Ltd.

In Canada as elsewhere, the fine performance and reliability of Lectromelt arc furnaces is contributing in a vital way to the increased tempo of armament programs. Built in standard sizes from 100 tons to 250 pounds capacity, Lectromelt top charge furnaces are showing appreciable savings in power, refractories, electrodes and man-hours.

IN CANADA
Lectromelt Furnaces of Canada, Ltd.
TORONTO

IN UNITED STATES
Pittsburgh Lectromelt Furnace Corp.
PITTSBURGH, PENNSYLVANIA

DOMINION FOUNDRIES

use **"TOOL STEEL"**
homogeneous alloy steel
WORK ROLLS in their
cold mills.

THE TOOL STEEL GEAR & PINION COMPANY
CINCINNATI, OHIO

GENERAL LAYOUT of
Steel Co. of Canada, Hamilton, Ontario

STEEL COMPANY of CANADA, Ltd.

By T. J. Ess, with personnel photographs by J. R. Scott

▲ THE Steel Company of Canada, Ltd. was formed in 1910 through the combination of the Hamilton Steel and Iron Company, Ltd., the Montreal Rolling Mills Company, the Canada Screw Company, Ltd., the Dominion Wire Manufacturing Company, Ltd., and the Canada Bolt and Nut Company, Ltd. These five enterprises were rich in the industrial traditions of the Dominion, being the outgrowths of about 48 smaller companies dating back forty years or more previous to that time. The years following the merger were devoted to bringing together the various constituents into an effective productive unit. Various alterations and new installations were made, including blooming, billet, rod and sheet mills, by-product coke plant, and much auxiliary equipment in the steel producing units, as well as in the various finishing plants. Improvements in the Welland Canal in 1931, together with the completion of a coal and ore dock at the Hamilton plant, allowed large lake boats to unload directly into the plant storage yard. A continuous expansion of productive capacity proceeded apace, until the company today comprises a completely integrated unit (of over 1,000,000 tons of ingots annual capacity), with wire and wire-product plants at Hamilton, Lachine, Montreal, and London, bolt and rivet plants at Brantford and Toronto, a forge plant at Gananoque, and a pipe mill at Montreal, in addition to the main Hamilton Works, which supplies the steel to the various fabricating plants, and with which this article is chiefly concerned.

A list of the products of the company is a veritable listing of the industry's products: coke, sulphate of ammonia and pig iron; ingots, blooms, billets and sheet bars; sheared and universal plate; iron and steel merchant bars; hot rolled annealed sheets; hot rolled pickled sheets; galvanized sheets; tin plate; black and galvanized wrought pipe; tie, fish and nail plates; wire rods, plain, galvanized and tinned wire; wire and cut nails, tacks, staples; barbed wire and wire fencing; bolts, nuts, rivets and washers.

Coke Plant and Blast Furnaces

The Hamilton plant is located at Hamilton, Ontario, on the shore of Burlington Bay, an almost land-locked body of water forming the westerly tip of Lake Ontario. The ore and coal used in the plant are brought in by boat from properties in which the company has ownership interest — iron ore mines in the Lake Superior district, and coal mines in Green County, Pennsylvania. Limestone is obtained from Beachville, Ontario, about fifty miles from the plant. The unloading deck is 1800 ft long, with a storage capacity in excess of 750,000 tons, and a minimum depth of 22 ft of water is available along the dock frontage. The storage yard, lying along the dock, is served by two 11-ton bridges of 375 ft span and an overall length of 674 ft with a third duplicate bridge under construction. These bridges handle all material

Two 40-oven batteries of coke ovens carbonize 1800 net tons of coal per day.

H. G. HILTON

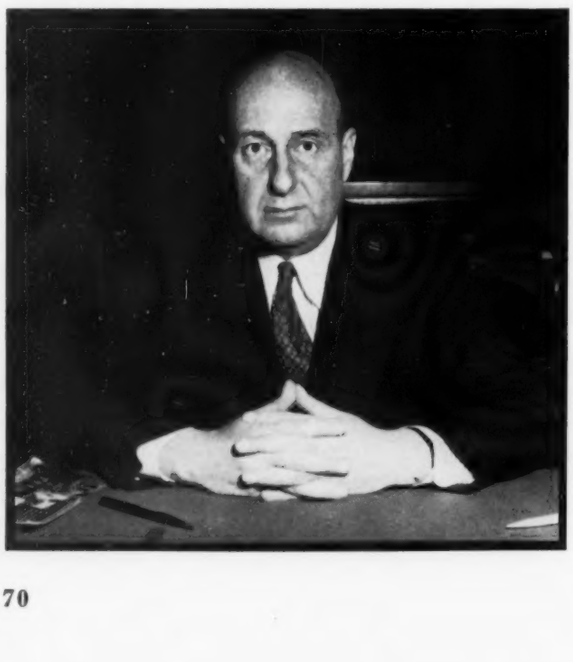
Vice President

from boat to storage, and from storage to car, operating at a rate of about 400 tons per hr each.

Coal for coking is dumped from cars into a receiving hopper, and passes on through a handling system of conventional design, including conveyor, breaker, mixing bins and table, hammer mill, and storage bunker. The 1400-ton bunker feeds a four-hopper charging car running along the top of the oven batteries.

R. A. GILLIES

Works Manager



Coking facilities consist of two batteries of 40 ovens each, placed end to end. The ovens, which are 37 ft 3 in. long x 10 ft 5½ in. high x 16½-19 in. wide, with an effective volume of 519 cu ft, take a charge of about 12.5 tons of dry coal, and are heated by 28 vertical flues each. Air for combustion of the gas is supplied by fans, while other fans provide induced draft for the removal of the waste gases, which are exhausted through two stacks 75 ft high.

The coal mix charged to the ovens consists of 87 per cent high volatile Pittsburgh seam coal, and 13 per cent low volatile Pocahontas coal, crushed fine enough for 80 per cent to pass a ⅛ in. screen.

At capacity operations 137 ovens are pushed per day, carbonizing about 1800 net tons of coal per day and producing 1370 tons of coke. Total coke yield, including breeze, is about 80 per cent, or 10 tons of coke per oven. By-product recovery, which follows conventional lines, shows averages of 10.2 U. S. gal of tar, 3.95 U. S. gal of light oils, 21.8 lb of ammonium sulphate, and 10,210 cu ft of gas per ton of dry coal.

F. M. RICH

Assistant to Works Manager and Vice President

The coke produced in the plant is insufficient to meet the present demands of the blast furnaces. The shortage is made up by purchases from the nearby plant of the Hamilton By-Product Coke Ovens, Ltd.

Pig iron is produced in three blast furnaces, one with an 11 ft hearth, one with an 18 ft hearth, and the third with a 22 ft hearth. The last-mentioned furnace is a recent installation, having started operations in September, 1941. It is 101 ft 2 in. overall height and is supported on 12 columns. The crucible is 11 ft high, the sloping bosh section is 11 ft high, and is topped with a straight bosh section 15 ft high and 26 ft in diameter. The inwall section is 45 ft high and is topped by the stockline section, 6 ft 6⅜ in. high x 18 ft 6 in. in diam-

eter. The bosh slope is therefore 2.182 in. in 12 in., or a bosh angle of 79 , 41′, 43″. The inwall slope is 1 in. in 12 in. The iron notch is placed 2 ft 4 in. above the hearth, the cinder notch is 4 ft 7½ in. above the iron notch and the tuyeres are 3 ft 0½ in. above the cinder notch. A bustle pipe of 3 ft 6 in. inside diameter distributes the hot blast to the 12 tuyeres. The furnace is topped with a 14 ft bell of 50 degrees, a 6 ft small bell and a revolving distributor top. Four off-takes merge into two risers, which in turn merge into a single downcomer.

Material is delivered to the new furnace bins on a two track high line. Coke is dumped into two brick lined central coke bins from which it is periodically drawn, while ore, stone, scrap, and other raw materials are dropped into the bins on either side of the double-sided stockhouse. When needed the material is drawn by means of hand operated gates into a 15-ton, single hopper, bottom dump scale car. The car dumps material through a lined chute into either of two bale type skips.

By means of air cylinder operated gates at the bottoms of the central bins, coke is fed onto stationary bar screens and drops into the weigh hopper. The coke may be automatically measured by weight or volume before dumping from the hoppers at either side of the skip pit into the skip cars. Chutes beneath the bar screens guide the coke breeze onto a moving belt conveyor which connects with the breeze disposal system of the other furnaces.

The loaded skip is hoisted to the receiving hopper atop the furnace by a single drum skip hoist. This hoist, operated by a single motor, single generator, Ward-Leonard type system, is capable of lifting a maximum of 26,000 lb of material 198 ft along the skip bridge at a speed of either 150, 300, or 500 fpm.

The bells are operated by means of low pressure air actuated cylinders. The large bell rig consists of a beam connected to a straight line motion linkage which in turn supports one end of the large bell rod. The small bell is operated through a beam fitted with a quadrant and chain. The bells and the revolving distributor are coordinated with the skip hoist by an automatic interlocking charging control. One interesting feature of this furnace is a guide bushing on the large bell rod between bells. This restrains the bell from any swinging motion imparted by material sliding off the bell.

Three side-combustion stoves, 22 ft in diameter x 100 ft high, provide hot blast for the new furnace. Checkerwork, of 1 11/16 in. thickness, arranged with 2 9/16 in. flue openings, offers a total surface of 123,430 sq ft per stove. Gas is burned in proportioning pressure burners with integral fan, the stove cycle being approximately 7 hr on gas and 3½ hr on blast. Stove stack temperatures average about 300 F, and the hot blast temperature runs about 1100 F, being controlled by automatic mixer control.

The new furnace is equipped with a dust catcher 28 ft 6 in. in diameter and 57 ft high, followed by a two-stage wet washer 18 ft in diameter x 69 ft 10 in. high. Final gas cleaning is effected in disintegrating gas washers.

Blast for the three furnaces is provided by three 42 in. x 84 in. x 60 in. vertical engines, one 44 in. x 84 in. x 60 in. vertical engine, one 80 in. x 84 in. x 60 in. vertical engine, one 48 in. x 90 x 72 in. horizontal engine, and one 45,000 cfm turbo-blower, all operating on steam of 150 psi pressure.

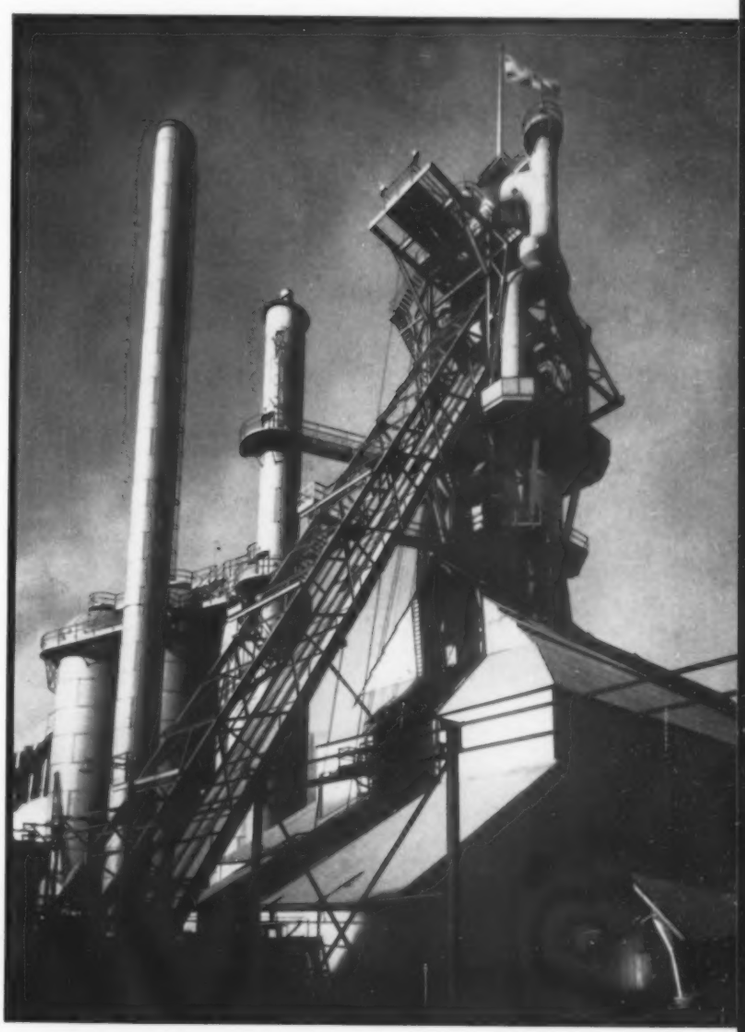
Performance of the three blast furnaces averages as follows:

Hearth diameter, ft	11	18	22
Kind of iron	Foundry	Basic	Basic
Net tons per day	365	755	950
Lb of coke per net ton of iron	1970	1580	1530
Lb of limestone per net ton of iron	810	740	645

Auxiliary equipment includes a two-strand pig casting machine and a sintering plant with a 10 ft x 24 ft pan.

Surplus gas from the blast furnaces and coke ovens is piped around the plant and mixed in various proportions at the points of usage. This gas system is one of the pioneer installations in this field, having been originated in 1929. Surplus blast furnace gas receives a final cleaning in disintegrators and flows to a gas holder of

The recently added blast furnace, with a 22 ft hearth, averages about 950 net tons of pig iron per day.



J. F. SLEE

Superintendent Blast Furnace and Open Hearth

1,000,000 cu ft capacity, which maintains a pressure of 20 in. of water. Nearly 5000 ft of riveted steel pipe, 5 ft in diameter and supported 35-40 ft above ground on steel towers, carries this gas to the consuming departments. From the coke plant gas holder, of 1,000,000 cu ft capacity, the debenzolized coke oven gas is boosted to a pressure of 5½ psi and delivered to consuming departments. Automatic controls at the points of usage allow the two gases to be mixed in constantly maintained proportions. This gas system was described in detail in a paper, "The Use of Mixed Gases for Steel Mill Operations," by E. T. W. Bailey, A. I. S. E. Yearly Proceedings, 1938, p. 563.

The remainder of the fuel supply for the plant is principally oil, which is transported mainly by boat, with some tank car shipments during the closed navigation season. A fuel oil storage capacity of about 7,200,000 U. S. gallons is provided.

Open Hearth

The later open hearth furnaces added in this plant are 175-ton units, of 77 ft 6 in. length overall. Bath dimensions at fore plate level are 43 ft 6 in. x 15 ft 6 in., with a depth of 2 ft 8 in. The furnaces are built with the McKune port design, in which the two conventional air uptakes are closed off on the incoming end by horizontal sliding dampers, the air entering through a central port through which fuel also is introduced. This port has an area of about 9 sq ft, and a slope of 3½ in. in 12 in., directing the flame on to the bath at a point between the first and second doors of the near end. The furnaces may be fired with mixed gas or fuel oil. Gas is carried into the central port from both sides of the furnace through 10 in. pipes, while a steam-atomizing oil burner may be inserted into the central port through the end wall.

The central port has a length of 8 ft 10½ in., and the fuel and air come into contact near the back end of the port, allowing fuel and air to mix and combustion to progress to a considerable extent before emerging from the port into the furnace laboratory.

On the outgoing end, the horizontal dampers are withdrawn, affording maximum area for removal of waste gases. Thus, to a considerable extent, the usual compromise between entry and exit requirements which exists in open hearth port design is overcome. The downtakes open into a common slag pocket, 15 ft x 15 ft 6 in.

Double regenerator chambers, 23 ft long x 11 ft 6 in. and 16 ft 1 in. wide, are completely encased in steel plate, eliminating all possibility of the effect of exterior moisture. Checkerwork, constructed of special shapes, is about 14 ft deep, giving a volume on each end of the furnace of 7823 cu ft, with an effective heating surface of 32,898 sq ft. Combined area of the vertical passages in the checkers is about 310 sq ft.

The furnaces have sloping backwalls and are completely insulated, including a 3 in. layer on the 15 in. furnace roofs.

There are five of these 175-ton furnaces, each equipped with a complete set of automatic controls and in-

Hot metal from the blast furnace is placed in an 800 ton mixer and subsequently transferred to open hearth furnaces by a 100 ton hot metal crane.

H. M. GRIFFITH
Superintendent Open Hearth

J. W. SHEPPARD
Superintendent Sheet Mills

struments, including fuel-air ratio, furnace pressure, roof temperature, and automatic reversal based on differential checker temperature. Air is supplied to each furnace by a fan rated at 24,000 cfm at 5 in. static pressure. As previously mentioned, blast furnace gas and coke oven gas are mixed at the point of usage, flowing from the mains into a mixing box and then on to the furnace at a pressure of about 10 in. water column. A ratio of 1:1, blast furnace gas to coke oven gas, has been proven a satisfactory mixture for the open hearth.

Beside the five large furnaces, No. 2 shop also contains four 100-ton furnaces of similar design. These units have bath dimensions of 37 ft 6 in. x 14 ft, and are also of the McKune design. No. 1 open hearth plant is composed of four 50-ton furnaces.

Located conveniently to each open hearth shop is a

W. A. WHITE
Superintendent Plate Mill

S. A. SMITH
Superintendent Bloom and Finishing Mills

Modern one-way fired soaking pits, burning mixed blast furnace and coke oven gas, form the principal ingot heating facilities.

J. F. MACDONALD

Superintendent Tin Plate Mill

large scrap yard, each served by two 10-ton overhead cranes. A similar yard nearby, containing a 5-ton crane, is devoted to pig iron storage. A 15-ton skull cracker crane is also provided.

At the present time, oil is the principal open hearth fuel, with some coke oven gas during off-peak periods. The fuel consumption averages about 3,400,000 Btu per ton of ingots.

Waste heat boilers are installed on all furnaces of the No. 2 open hearth shop, the 175-ton furnaces having 6000 sq ft horizontal fire-tube boilers, and the 100-ton furnaces, 5000 sq ft vertical water tube boilers. These units are also fired with gas or oil at times in order to meet steam demands in the plant.

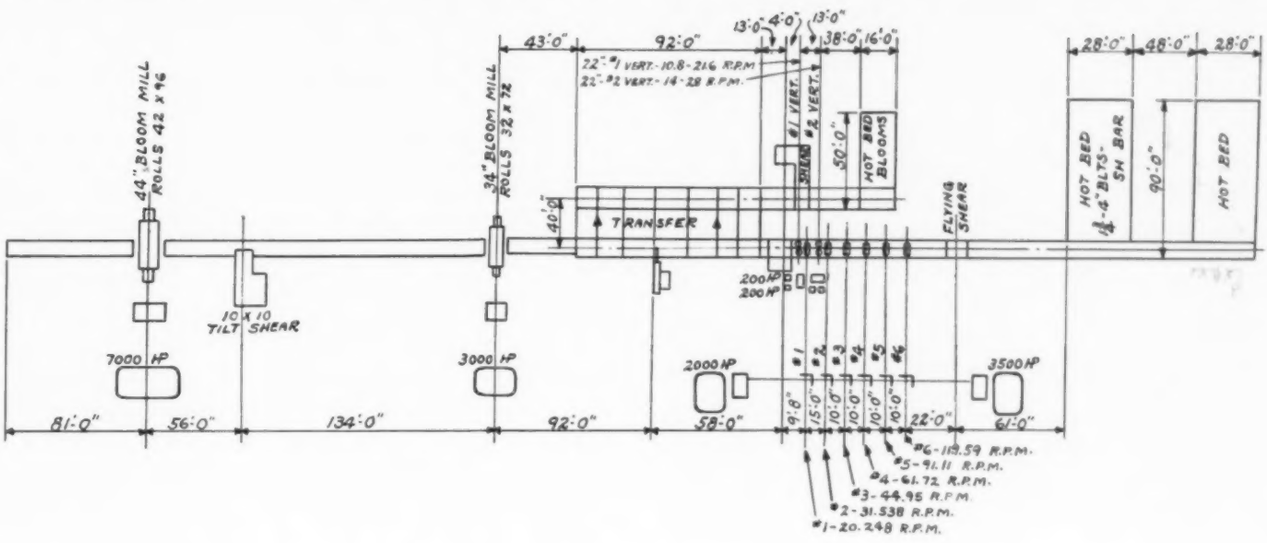
Production rates average about 13½ tons per hr in the 175-ton furnaces, 9 tons per hr in the 100-ton furnaces, and 5½ tons per hr in the 50-ton furnaces. Furnace charges are now constituted of 53 per cent hot metal and 47 per cent scrap, with about 8 per cent limestone. Hot metal is brought from the blast furnaces by transfer ladles with closed tops and dumped into an 800-ton mixer. Steel is produced over a carbon range of .04-1.10 per cent, with about 10 per cent of the product in the mild alloy category. About 40 per cent of the total product is killed, hot topped material; 15 per cent, semi-killed material; and 45 per cent, rimmed steel. All ladle additions are crushed and added to the metal stream in the tapping spout.

In No. 2 open hearth department there are three ladle cranes, one of 165/25 tons, one of 200/40 tons, and one of 250/40 tons, all of 50 ft span. A 100/40 ton hot metal crane, on 70 ft span, handles the iron ladle to the furnaces. Two auxiliary cranes serve the charging floor, and one is provided for the pit side. Three floor type machines charge scrap, etc., into the furnaces.

Due to the variety of product of the open hearths, a considerable range of ingot mould sizes and types are used. Big-end-down moulds from 28 in. x 39 in. to 28 in. x 48 in. are used, and weigh up to 18,000-22,000 lb. Hot-topped grades are usually poured into bid-end-up moulds, 22 in. x 24 in., 24 in. x 26 in., and 31½ in. x 31½ in., weighing respectively 8775 lb, 11,000 lb, and 16,500 lb. Open hearth ladles are constructed with double stopper rigs, allowing two ingots to be poured simultaneously. Some steel is bottom-poured, the ar-

C. J. PORTER

Electrical Engineer



Layout of blooming and billet mills.

rangement in No. 2 shop using a single sprue to supply the runners to two buggies of moulds, which are poured simultaneously. Much of the bottom-cast material is rimming steel, in moulds 12 in. thick, 26-42 in. wide, and 55-60 in. long, to be used for ship plate, etc.

Before each use, ingot moulds are sprayed with tar, using a pneumatic spray of unusual design, which requires no overhead crane service to use. A large building is devoted to the extensive mould preparation facilities.

H. A. JONES

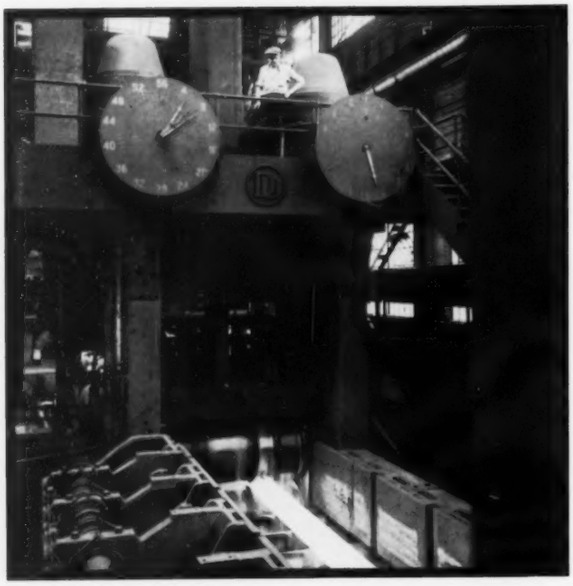
Master Mechanic and Machine Shop Superintendent

Blooming and Billet Mills

Two stripper cranes, of 100 and 200 tons capacity respectively, remove ingots from their moulds, and the ingots are then placed in the soaking pits. In addition to two 4-hole rows of reversing, regenerative soaking pits, there are 12 holes of modern one-way recuperative pits, 12 ft 9 in. x 13 ft 6 in. x 7 ft 3 in. Mixed gas of about 135 Btu per cu ft is introduced to the pit through a single burner located in the middle of the bottom. Waste gases are drawn off through flues placed at each corner of the pit, and flow to a refractory tile recuperator which preheats the air used for combustion to a temperature of about 1700 F. Overall fuel consumption averages about 875,000 Btu per ton of ingots, with the modern pits showing figures as low as 600,000 Btu per ton.

Three 10-ton pit cranes handle ingots into and out of the soaking pits.

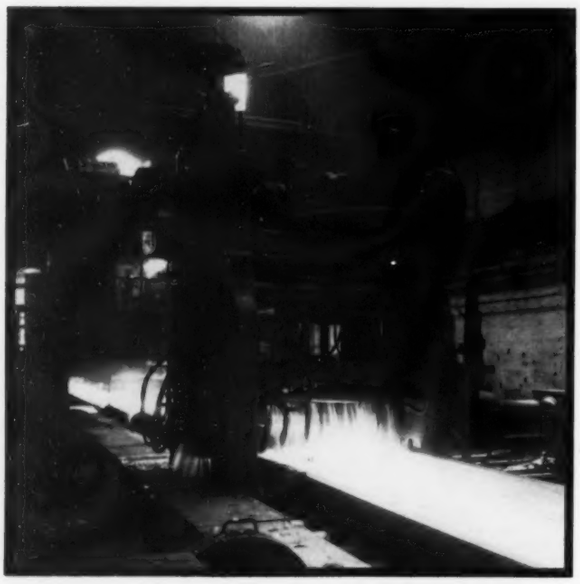
The blooming mill consists of two independent two-high reversing units in tandem. Ingots are first brought to the 44 in. mill, which was installed in 1938 in order to increase breakdown facilities. This mill uses rolls 42 in. in diameter x 96 in. barrel length, operating in composition bearings. Mill screws, of 15 in. diameter, are operated by two 150 hp motors, and the entire screwdown mechanism is equipped with roller bearings. The mill is driven by a 7000 hp, 0-50-120 rpm, 700 volt, reversing compound wound motor, served by a dual flywheel set composed of two 3000 kw, 700 volt, d-c generators, and one 5000 hp, 370 rpm, 6600 volt, 25



A 44 in. reversing mill forms the primary breakdown unit, and feeds into a 34 in. reversing unit.

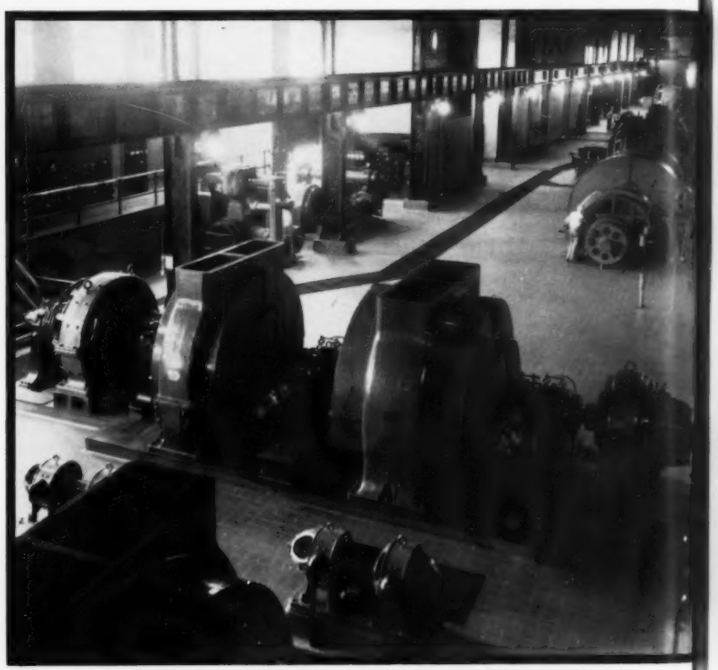
cycle, wound rotor motor. Mill spindles are of the universal type, the top spindle being hydraulically balanced, as are the mill rolls. The mill has a high lift, allowing edge rolling on slabs up to 51 in. wide. Electrically driven manipulators, of the rack type, are installed on both sides of the mill, with all driving mechanism on the spindle side of the mill. One sideguard on the exit side of the mill is equipped with tilting fingers.

This 34 in. reversing mill, in tandem with the 44 in. mill, finishes the breakdown on smaller size blooms.



Located 190 ft from the 44 in. mill is a 34 in. unit, employing rolls 32 in. x 72 in. running in composition bearings, and driven by a 3000 hp, 0-70-100 rpm, 600 volt, shunt wound motor. This motor receives power from a flywheel set consisting of two 2000 kw, 600 volt, d-c generators driven at 500 rpm by a 2000 hp, 6600 volt, 25-cycle wound rotor motor. Hydraulic manipulators are installed on this mill.

Between the 44 in. and the 34 in. mills, a 10 in. x 10 in. horizontal tilting crop shear is installed, so designed that it may be depressed below the mill tables when not operating, eliminating any interference with free passage of material from either mill. A hot saw and transfer are placed on the exit side of the 34 in. mill, and blooms may be removed at this point or may proceed down the mill table to an 18 in. continuous billet mill, consisting of six two-high stands and two stands of vertical rolls. An unusual drive arrangement operates the six horizontal mill stands, in which a 3500 hp, 400 rpm, 2200



In addition to blooming mill drives, this motor room contains distribution and auxiliary equipment serving the greater part of the plant.

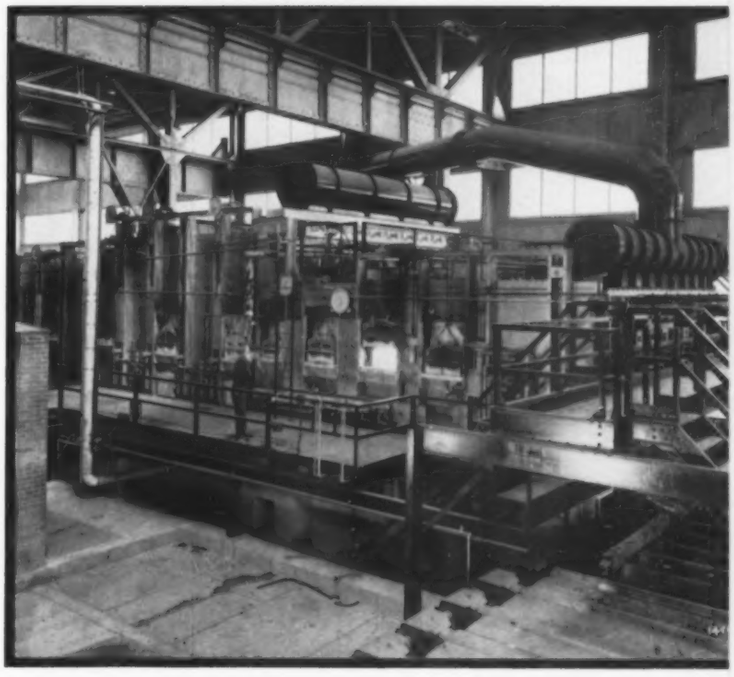
volt, 66 cycle, induction motor and a 2000 hp, 500 rpm, 6600 volt, 25 cycle, induction motor operate through separate gear reductions of 2.927 and 3.659 ratios, respectively, on opposite ends of the main drive shaft. Gearing on each stand is so proportioned as to give successive mill speeds of 20.248, 31.538, 44.95, 61.72, 91.11, and 119.59 rpm. Roll neck bearings are of lignum vitae, with bronze thrust bearings. Vertical rolls precede the first and second stands, and each set is driven by two 200 hp, 410-820 rpm, 230 volt, d-c motors, at speeds of 10.8-21.6 and 14-28 rpm, respectively. These motors are fed from a special 750 kw motor-generator set.

From the mill, tables proceed past a steam-operated flying shear and onto two hot beds approximately 28 ft x 90 ft.

In general, ingots are broken down to 10 in. x 10 in. or 11 in. x 11 in. blooms in about 18 passes in the 44 in. mill. Slabs 30-42 in. wide and 4-12 in. thick are rolled directly in the 44 in. mill. Blooms may be further reduced to 5¾ in. squares in 11 passes, or to slabs for sheet bar, in the 34 in. mill. Billet mill product may range from 1¾ in. squares to 4 in. squares, slabs 3 in. x 4 in., 5 in. x 6½ in., etc. Sizes up to 2 in. are delivered from No. 6 stand at a speed of 590 fpm.

Larger sizes are delivered from No. 4 or No. 2 stand. The mill employs diamond-square reductions, the vertical rolls eliminating the twisting of heavy sections in the process. When set up for sheet bar, material of 8, 10, and 12 in. widths is rolled. The entire breakdown group operates at an average rolling rate of about 120 net tons per operating hour. Hydraulic sprays on the blooming and billet mills aid in maintaining a product surface of high quality by effective scale removal.

Close inspection is maintained in checking for surface defects on blooms and billets. Such defects are removed by chipping or flame scarfing. Oxygen for the scarfing operation as well as for other plant uses is purchased from a nearby manufacturer and piped throughout the greater part of the plant.



A 20 ft x 80 ft triple-zoned slab heating furnace, fired with fuel oil, serves the plate mill.

▲

The plate mill, 38 in. and 52 in. x 110 in., is driven at 0-35-80 rpm by a 5000 hp reversing motor.

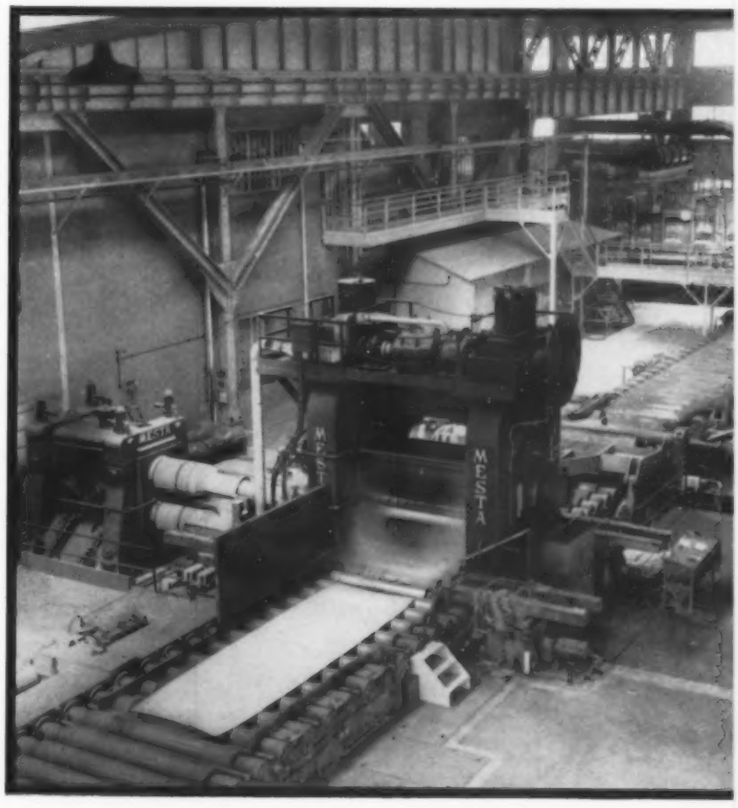


Plate Mill

Early in 1941 operations were started on a new, 4-high, 110 in. plate mill. This unit is so located and laid out that, should it be so desired, it may ultimately serve as the roughing mill for a continuous strip finishing line. At present there is a single heating furnace of triple zone design, end charged, end discharged. The hearth is 20 ft wide x 80 ft long, 17 ft 3 in. of the length being of solid construction for the soaking zone, while the remainder is spanned by water-cooled skid pipes. The furnace is fired with steam-atomized fuel oil, six burners being installed in the top heating zone, six in the bottom zone, and eight in the soaking zone. Air for combustion is preheated in a carborundum recuperator employing core-busters, and natural draft is provided by a stack. A 45,000 cfm fan pulls air through the recuperator and delivers it to the burners. A complete lay-out of controls is provided, including furnace pressure, fuel-air ratio, fuel-steam ratio, soaking zone temperature and top heating zone temperature. Fuel consumption averages about 2,400,000 Btu per net ton, charged weight.

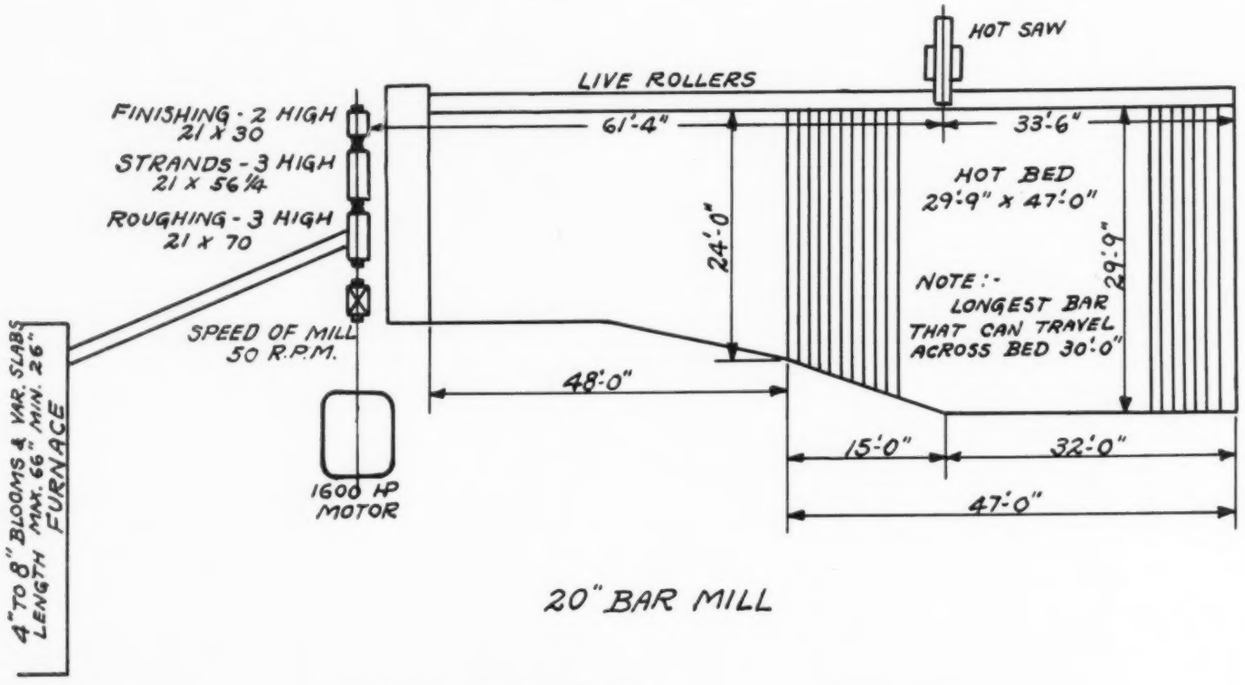
Slabs are moved through the furnace by two electrically driven rack-type pushers. Electrically operated elevators, which raise slabs up to the furnace pushers, are stocked by a 25/15 ton crane, which serves the slab yard. This yard is 450 ft x 100 ft and also contains a slab preparation bed, 250 ft x 30 ft, served by a 7½ ton semi-gantry crane.

About 112 ft down the mill table from the furnace a stand of vertical edger rolls is placed. This is driven by a 500 hp, 700 volt, 125-406 rpm, d-c motor, and the rolls, which operate in roller bearings with bronze thrust collars, are adjustable up to a maximum opening of 110 in. Spaced 31 ft 4 in. from the vertical rolls is the 4-high reversing unit, using work rolls 38 in. x 110 in. and backup rolls 52 in. x 108 in. Roller bearings are applied to

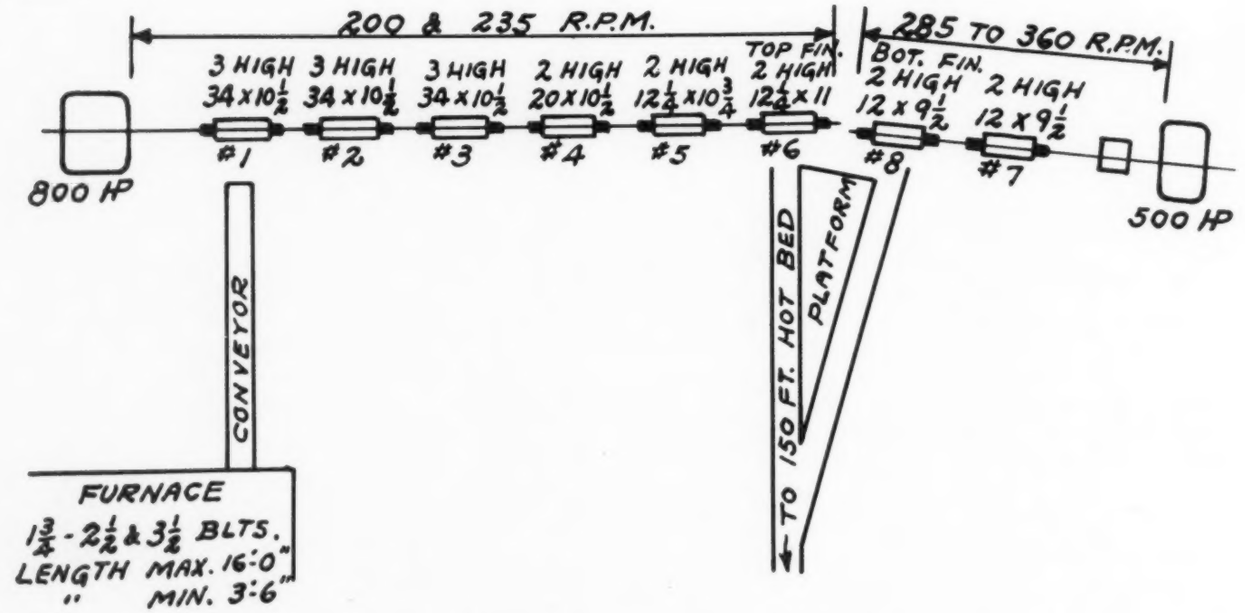
the work rolls, while the back-up bearings are of the oil film type. This stand is driven directly from a 5000 hp, 0-35-80 rpm, 700 volt, compound wound motor. Mill screws, of 1 in. pitch, are actuated by two 75 hp, 515 rpm, 230 volt d-c motors, with gearing resulting in a lift of .0597 in. per revolution of the motor. Maximum roll lift is 15⅛ in. Slab turntables are provided on each side of the 4-high stand, with pneumatic lift and electrically operated turning mechanism.

Slabs are descaled by hydraulic sprays on each side of the 4-high stand, top and bottom. High pressure water is furnished by a six-stage centrifugal pump rated at 500 gpm, 1000 psi, and driven by a 500 hp induction motor. A pneumatic accumulator is provided in this hydraulic system.

Seven central oiling systems provide lubrication for mill pinions, back-up rolls, edger, screwdown mechanism, mill tables and drive motors. Two automatic

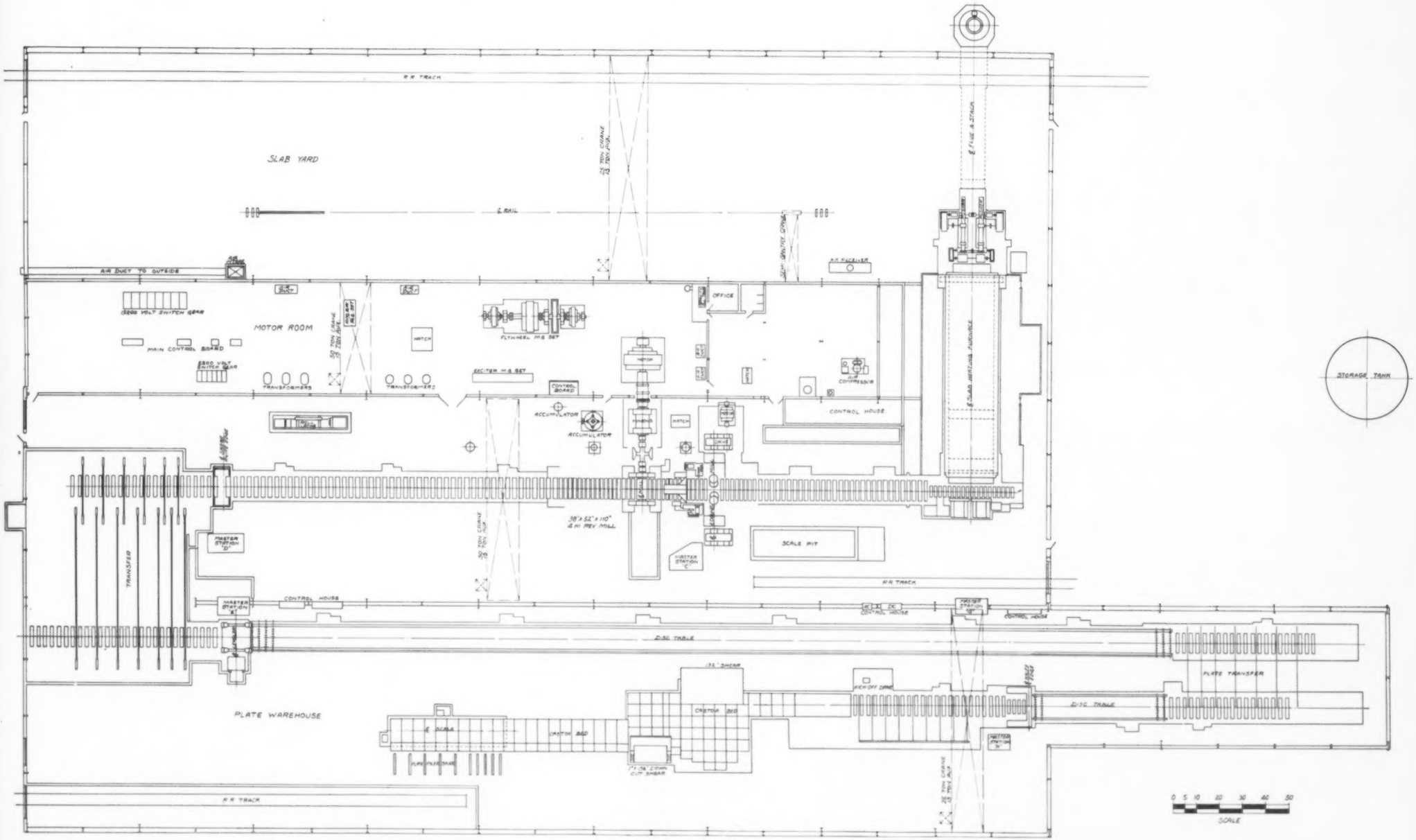


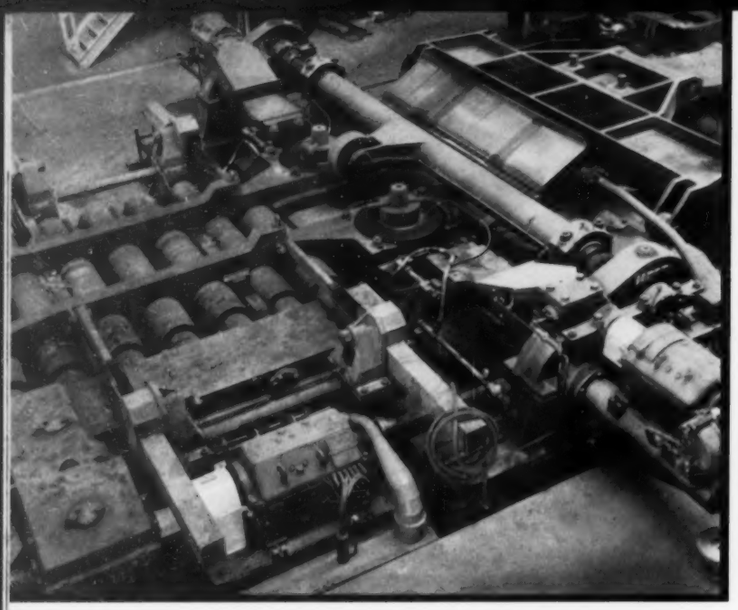
20" BAR MILL


200 & 235 R.P.M.
285 TO 360 R.P.M.
3 HIGH 34 x 10½ #1
3 HIGH 34 x 10½ #2
3 HIGH 34 x 10½ #3
2 HIGH 20 x 10½ #4
2 HIGH 12¼ x 10¾ #5
TOP FIN. 2 HIGH 12½ x 11 #6
BOT. FIN. 2 HIGH 12 x 9½ #8
2 HIGH 12 x 9½ #7
800 HP
500 HP
CONVEYOR
FURNACE
1¾ - 2½ & 3½ BLTS.
LENGTH MAX. 16'-0"
" MIN. 3'-6"
TO 150 FT. HOT BED
PLATFORM

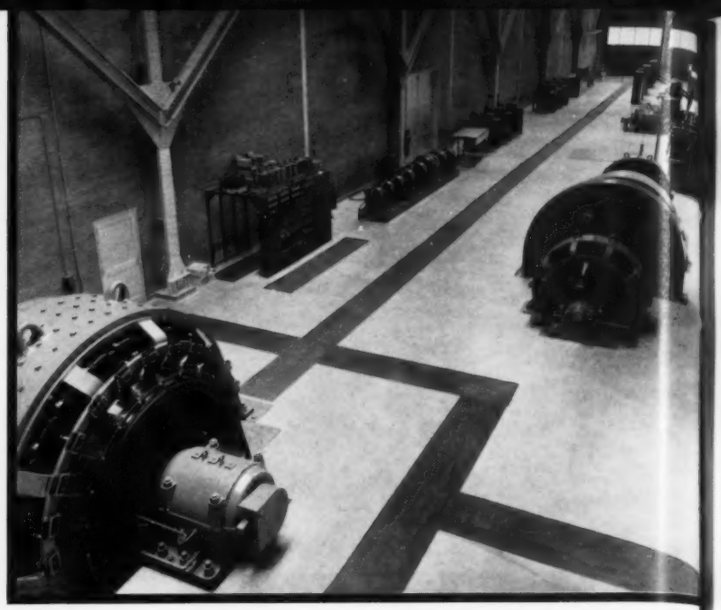
10-9 MERCHANT MILL

Layout of plate mill





Slab turn tables are provided on each side of the mill with pneumatic lift and electrically operated turning mechanism.



The plate mill motor room, which follows modern design practice, also acts as a power distribution center for the new mill.

grease systems serve the mill and its tables. A number of manual grease systems are provided for auxiliary equipment.

The hot mill building is 450 ft long x 90 ft wide and contains one 50/15 ton crane.

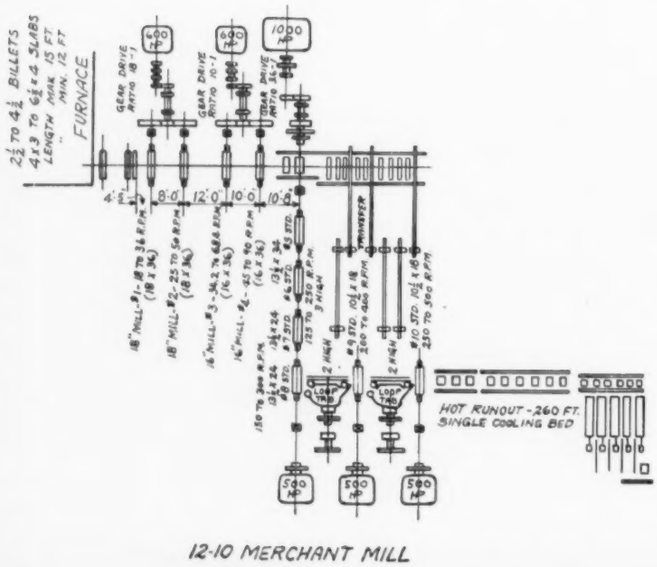
Power for the main drive and the edger drive is supplied by a dual flywheel set composed of two 2500 kw, 700 volt, d-c generators driven at 490 rpm by a 5000 hp, 13,200 volt, 25-cycle wound rotor motor, controlled by a slip regulator. This set is located in the motor room, 300 ft long x 50 ft wide, and served by a 50/15 ton crane.

The motor room also houses a 1000 kw motor-generator set for plant d-c power, an exciter set, three 1000 kva, single phase, 13,200/2200 volt transformers, three 500 kva, single-phase, 13,200/440 volt transformers, and all necessary switchgear and control boards. Storage batteries for emergency operation of switchgear, together with a charging set are installed in the basement of the motor room. All rotating machines are cooled by a closed, recirculating, ventilating system in which the air is cooled in the surface type fin tube coolers in the basement, forced up into the motor room and down through the machines.

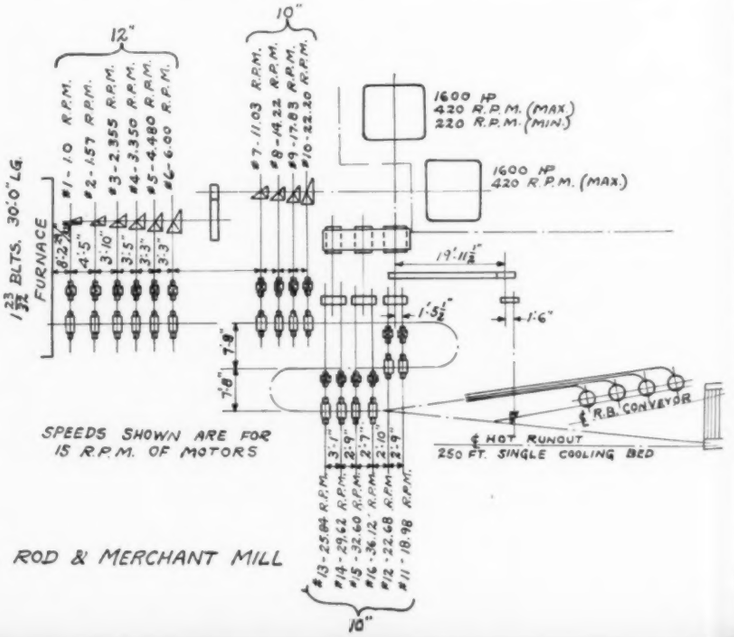
From the 4-high stand, the mill table proceeds for a distance of 184 ft 8 in. to an up-and-down cut, dividing shear designed for sections up to 1 in. x 100 in. All tables are driven through gears and line shafts by 50 hp mill type motors, and operate at speeds up to 500 fpm. Table rollers run in roller bearings, and are spaced on 2 ft 6 in. centers on the mill tables and on 3 ft centers on the runout table.

A 50 ft, chain-and-dog type transfer connects the runout table to a parallel cooling table about 550 ft long. After passing through a roller leveler, the plate is carried over disc-type rollers at speeds of 100-300 fpm. Another transfer, of cable-and-dog type conveys the plate to a second parallel table, in which is installed a 1 in. x 100 in. end shear. Universal plate is then kicked off onto pilers, while sheared plate is taken over castor beds to either of two side shears, designed for maximum thicknesses of 1 in. and 1¾ in., respectively.

The cooling tables are located in the plate warehouse



12-10 MERCHANT MILL



ROD & MERCHANT MILL

and shipping department, which is 600 ft long and 100 ft wide and served by one 25/15 ton and one 10 ton crane. Oxyacetylene cutting machines and a segment shear afford facilities for cutting plates as may be desired.

The plate mill reduces slabs 4-12½ in. thick, 20-45 in. wide, and 1500-16,000 lb in weight, down to plates 3/16 in. to 6 in. thick and 20-96 in. wide. About 25 per cent of the steel rolled in the plate mill comes directly as bottom-cast ingots 12 in. thick and 26-42 in. wide. Reductions on the slab in the mill average about 35 per cent in each pass, dropping to about 10 per cent for finishing passes. An average rolling rate of 30 net tons, finished weight, is maintained.

Merchant and Rod Mills

The 12-10 in. merchant mill has a nominal capacity of 10,000 net tons of merchant bar per month, producing ½ in.-3 in. rounds, ½ in.-2½ in. squares, 1 in-4 in. angles, flats from 1¼ in. x 3/16 in. to 6 in. x 1 in., and a number of miscellaneous special sections. Billets come to the mill ranging from 2½ in. to 4½ in. squares, as well as in several slab sizes, and are heated in a continuous side-charge, side-discharge heating furnace, with

E. T. W. BAILEY
Steam Engineer

HARRY EVANS
Roll Designer

C. E. CHRISTOPHER
Special Engineer

a hearth 55 ft x 17 ft. The furnace is designed with two firing zones, top-firing. Seven burners are installed in each zone, using fuel oil in the heating zone and coke oven gas in the soaking zone. Air for combustion is preheated in a refractory tile recuperator. Fuel consumption averages about 1,500,000 Btu per ton of product.

The mill proper consists of a 4-stand continuous roughing train, three intermediate stands, and three finishers. The first two roughers are 18 in. units, driven by one 600 hp, 450-900 rpm, 600 volt d-c motor, through gearing selected so as to give roll speeds of 18-36 and 25-50 rpm, respectively. The next two roughers are 16 in. stands, driven at 34.2-68.4 rpm and 45-90 rpm by a duplicate motor. The roughing stands are spaced 8 ft, 12 ft, and 10 ft apart. A single d-c motor, 1000 hp, 450-900 rpm, 600 volt drives three intermediate stands, the first two of which are 3-high, while the third is 2-high. These stands are located side by side on a common shoe plate and operate at 125-250 rpm. The last three stands are placed in tandem and driven individually and directly by 500 hp, 600 volt, d-c motors. Speeds of the respective motors and stands are 150-300, 200-400 and 250-500 rpm. From the mill, the runout table extends 260 ft to a single cooling bed. Runout table rollers are individually driven by 116 small variable frequency

motors rated at .8-.3 hp, 350-117 volts, 40-13.3 cycles.

The smaller sections are delivered from No. 10 stand at a speed of 1200-1400 fpm, while larger sizes are finished in No. 8 stand at speeds of 600-800 fpm. The rate of production of the mill varies considerably with the section being rolled, but averages about 26½ net tons per hr. This mill is equipped with composition roll neck bearings and bronze thrust bearings on the roughers and finishers, while stranding rolls run in babbitt bearings.

Power for the drive motors is obtained from a motor-generator set made up of two 2000 kw, 600 volt d-c generators and a 5750 hp, 500 rpm, 6600 volt, 25-cycle, synchronous motor.

Hydraulic sprays at some of the stands of this mill insure effective removal of scale from the product.

Another merchant mill, the 10-9 in. mill, consists of eight stands placed side by side in conventional looping mill arrangement. The first three stands are 3-high and the remainder 2-high. The first six stands, all 10 in. units with brass bearings, are driven directly by an 850 hp, 285-235-200 rpm, 220 volt, 66 cycle, 2-phase, cascade induction motor. The last two 9 in. stands, equipped with lignum vitae bearings, are driven through gears at 360 rpm by a 500 hp, 780 rpm, 2200 volt, 66 cycle, wound rotor motor.

This mill produces rounds $\frac{19}{64}$-$1\frac{21}{32}$ in., squares ¼-1⅝ in., angles ¾-2 in., and various other small shapes and sections at an average rate of about 9 tons per hr. Billets, usually 1¾ in., 2½ in., or 3½ in. squares, are heated in a continuous end-charge, side-discharge furnace. Hearth dimensions are 22 ft x 17 ft 6 in., with 4 ft 9 in. of the hearth length of solid construction. Seven steam-atomizing oil burners, in single zone, top-fired arrangement, serve the furnace, and fuel consumption averages about 2,750,000 Btu per ton.

To supply rod to the various wire mills of the company, there is a sixteen-stand rod mill of 12,000 tons per month nominal capacity. Billets, $1\frac{23}{32}$ in. square, are heated in a continuous end-charge, side-discharge, single zone furnace, 25 ft x 30 ft. Producer gas is burned in the furnace, with fuel consumption averaging about 1,690,000 Btu per ton. The heated billets first pass through a 12 in. continuous roughing line, with the six stands spaced from 4 ft 5 in. to 3 ft 3 in. apart. After a 20 ft interval are four 10 in. stands, spaced 3 ft 1 in. to 2 ft 7 in. The steel then loops back through two 10 in. stands, and again loops to pass through a 4-stand finishing line on 2 ft 9 in. centers. A single motor, 1600 hp, 220-420 rpm, 600 volt, shunt wound, drives the first 10 stands, and a duplicate motor drives the last 6 stands. Gearing is selected so as to give mill speeds approximately as follows:

	Roll rpm. maximum		*Roll rpm. maximum*
No. 1 stand.....	28	No. 9 stand....	499
No. 2 stand.....	44	No. 10 stand....	621
No. 3 stand.....	66	No. 11 stand....	531
No. 4 stand.....	94	No. 12 stand....	635
No. 5 stand.....	125	No. 13 stand....	724
No. 6 stand.....	168	No. 14 stand....	830
No. 7 stand.....	308	No. 15 stand....	913
No. 8 stand.....	380	No. 16 stand....	1012

This mill is equipped with babbitt and brass bearings and composition thrusts.

Finished rod is delivered at speeds up to 3300 fpm, heavy rods proceeding onto a 250 ft single cooling bed, while the lighter materials is guided to four coilers. The mill produces rod from No. 5 up to $\frac{33}{64}$ in., at rates of 21-25 tons per hr. A dual motor-generator set, with two 1200 kw, 575 volt d-c generators and a 3200 hp, 500 rpm, 6600 volt, 25 cycle, synchronous motor, provides power for the two main drive motors. One generator serves the roughing motor and the second serves the finishing motor.

A patenting furnace is provided, in which high carbon wire rods intended for the manufacture of spring wire is normalized before shipment to the wire mills for subsequent drawing.

At the Ontario Works, located several miles from the main Hamilton plant, there is a 20 in. bar mill consisting of three stands, side by side and driven at 50 rpm by a 1600 hp, 280 rpm, 2200 volt, 66 cycle, wound rotor motor. The rougher is a 21 in. x 70 in., 3-high stand, the strander is a 21 in. x 56¼ in., 3-high stand, and the finisher, a 21 in. x 30 in. 2-high stand, all equipped with babbitt bearings. The mill produces 1¾-5½ in. rounds, 1⅝-4¼ in. squares, flats up to 8 in. wide, etc. at a rate averaging about 10 tons per hr. High and low carbon tie plates and heat treated splice bars are also produced. Square blooms, 4-8 in., and various slab sections are heated in a continuous, end-charge, side-discharge furnace, 47 ft 6 in. x 14 ft. Fuel oil is burned in eight burners, four in each of the two top-fired zones, with fuel consumption averaging about 2,670,000 Btu per net ton of product.

Sheet Mills and Miscellaneous Departments

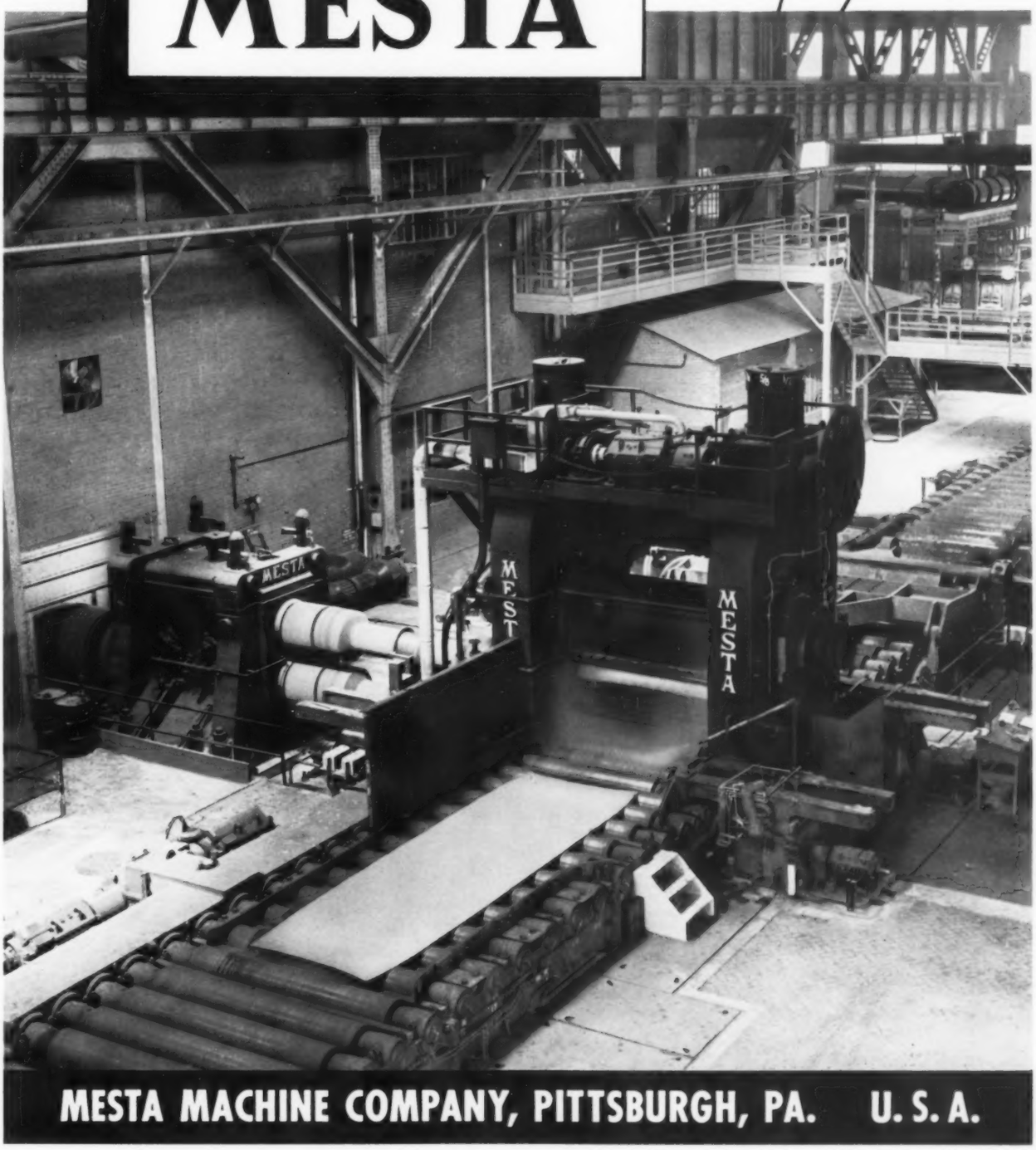
Sheet rolling is performed on mechanized sheet mills, with a monthly capacity of about 13,000 tons. One 3-high breakdown mill, with a continuous furnace and automatic tables, and two 2-high breakdown mills, served by a continuous double-lane furnace, supply breakdowns to four finishing mills, which are also equipped with continuous furnaces and automatic feeding and catching equipment. There are also two jobbing mills and a conventional hand sheet mill. Sheet mill furnaces operate on mixed gas, about two parts blast furnace gas to one part coke oven gas. An automatic pack shear trims practically the entire output from the sheet mills.

Finishing equipment is provided for the processing of almost every type of sheet product. Annealing facilities include 5 radiant tube portable covers, burning coke oven gas, and 12 in-and-out furnaces, using a mixed gas of about 120 Btu per cu ft. Steam bluing is also performed in the annealing boxes. Air bluing is done in the open annealing furnaces following the jobbing mills. Other equipment includes two 4-arm vertical plunger picklers, one rocker-type pickler, one white pickler, cold mill stands, a normalizer, stretcher and roller levelers, oilers, etc. Three galvanizing pots provide a monthly tonnage of about 4000 tons of galvanized sheets. Five tinning lines are also installed and operate on purchased material, as no black plate is produced by the company as yet. (*Please turn to page 84*).

110" FOUR HIGH REVERSING PLATE MILL

BUILT BY

MESTA



MESTA MACHINE COMPANY, PITTSBURGH, PA. U. S. A.

Main drive units in the sheet mill consist of one 1600 hp, 210 rpm motor and two 750 hp, 735 rpm motors on the hot mills, and two 450 hp, 735 rpm motors on the cold mills, all wound rotor units of 6600 volts, 25 cycle.

The Hamilton plant also includes a number of miscellaneous departments which further fabricate or process steel produced in the plant. In the reinforcing department, facilities are provided for bending and shaping high and low carbon material, threading bar ends, etc., as may be required in the production of various grades and sizes of plain and deformed reinforcing bars. Several hundred tons a month of standard railway, shimming, and large and small pressed spikes are produced in another department. A wide range of washer sizes is also produced. Facilities are available for annealing special grades of bars as well as producing pickled and oiled or pickled and limed material.

Plant Services

Power for the Hamilton plant is supplied by the utility company serving the district at 13,200 volts, 3 phase, 25 cycle, and is transmitted entirely by means of underground cables. Four 3-conductor, 350,000 cir mil stranded 15,000 volt cables, paper insulated and lead covered, carry power to the blooming mill powerhouse, and two duplicate cables lead to the plate mill substation. At the blooming mill power house two 15,000 kva transformer banks step the power down to 6600 volts, which is then distributed throughout the plant with the exception of the plate mill, totaling a connected load of 47,987 hp. At the plate mill, as previously mentioned, some power is used at 13,200 volts, with some being stepped down to 2200 and 440 volts. The plate mill represents a connected load of 8655 hp.

In the foregoing description of the plant, it will be noticed that two frequencies are used. This results from the fact that the original power supply for the plant was at 66⅔ cycle. When the 25 cycle supply was adopted, most of the large motors were changed over to the new frequency. Small motors, however, and two large motors, were not changed over. To supply these units two frequency changer sets were installed in the blooming mill power house. Each of these units consists of a 3500 kw, 2200 volt, 66⅔ cycle alternator, driven by 5750 hp, 6600 volt, 25 cycle, synchronous motor, and carries on the same shaft a 200 kw, 125 volt, d-c exciter and a 750 kw, 250 volt generator for general plant d-c power. The neutrals of the winding of each 5750 hp motor and each 3500 kw alternator are grounded through separate resistances, with switching arranged so that only one motor and one alternator is grounded at a time. This permits the use of ground leakage current relay protection on any 6600 volt, 25 cycle feeder and any 2200 volt, 66⅔ cycle feeder. This arrangement has provided very satisfactory protection for the underground 6600 volt and 2200 volt transmission systems through the plant.

The two points of incoming power are more than 2000 ft apart, and in order to totalize power load and demand, a combination system of metering was installed. This consists of the installation in each of the two main substations of a set of current and potential transformers on the 13,200 volt feeders. The secondaries of these transformers are connected to a polyphase watthour meter, a polyphase graphic thermal demand wattmeter and reactive kva meter, and a thermal converter. With these instruments, the simultaneous demands of the two power connections are totalized, recognizing the diversity of the two loads. With the plant operating at approximately full production, a combined 10 min demand of about 24,200 kw is set, with a load factor of approximately 70 per cent. A power factor of about 95 per cent is maintained. A listing of electric motors of the entire plant shows a total of 1887 motors, with a total rating of 111,517 hp.

General d-c power for the plant is supplied from three principal conversion points. Three 750 kw generators are located in the blooming mill powerhouse, two 500 kw sets are in the main pumphouse and two 500 kw sets in a substation about half way between these two points. At the blast furnace engine room there are also three stream-driven d-c generators, one of 300 kw and two of 200 kw, for emergency service.

Plant lighting is, in the main, on the 66⅔ cycle system, being served by an independent 2200 volt distribution system, with transformers (2200/220/110 volts) at the various distribution centers.

Seventy-seven electric cranes, of various types and capacities, serve the Hamilton Works.

Plant water, with the exception of that required for drinking, etc., is obtained from the bay, along the shore of which is located the main pumphouse. Water is drawn through a traveling screen to the 140 ft head centrifugal pumps, which include four 13,500 gpm and one 7000 gpm units, all motor driven. Four more 7000 gpm units, driven by gasoline engines, are available for emergency service. Plant requirements total about 65,000,000 U. S. gallons per day. Two 500 kw motor-generator sets in the pumphouse provide d-c power for the ore and coal storage yard.

Steam, to the extent of about 225,000,000 lb per month, is required for blast furnace blowers, coke plant exhausters and stills, oil atomization, heating, etc. This usage is supplied from three boiler houses, all tied in together and operating at 150 lb pressure. At the blast furnace there are two 400 hp units, eight 350 hp units and two 250 hp units, fired with blast furnace gas or oil. At the coke plant, one 314 hp boiler and three 250 hp boilers operate on coke breeze, while two 485 hp units burn blast furnace gas. In addition to these, there are also the waste heat boilers previously described. Feedwater is treated by the zeolite process for the blast furnace and coke plant boilers and by a hot process lime-soda system for the waste heat boilers.

A complete layout of maintenance shops affords facilities for the prompt, careful maintenance so necessary for the efficient operation of modern steel plant equipment. Comfortable, well-ventilated locker and wash rooms are provided throughout the plant.

Representing almost half of the steel production capacity of the Dominion, the Steel Company of Canada, Ltd., has played an important part in the industrial development of the country. At present, like industry in general, the company is devoting primary efforts to production for various phases of war and armament programs, and practically its entire production of steel is devoted to direct and indirect war needs.

For Your Billet and Bar Mills

Other Mackintosh-Hemphill Products:	Heat treatment of Billet and Bar Mill rolls, to provide that they give excellent
Rolling Machinery	
Shape Straighteners	service, is of utmost importance, as every mill operator knows. Here at Mackintosh-
Strip Coilers	
Shears	Hemphill we have the most modern equipment and the heat treatment phase of
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Iron-Steel Castings	exclusively by Mackintosh-Hemphill, in combination with proper heat treatment,
The NEW Abramsen Straightener	
Improved Johnston Patented Corrugated	has gained a wide approval of our rolls wherever steel is rolled.
Cinder Pots and Supports	*Since 1803—Pioneers, Engineers and Builders*
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PROCESS STEEL
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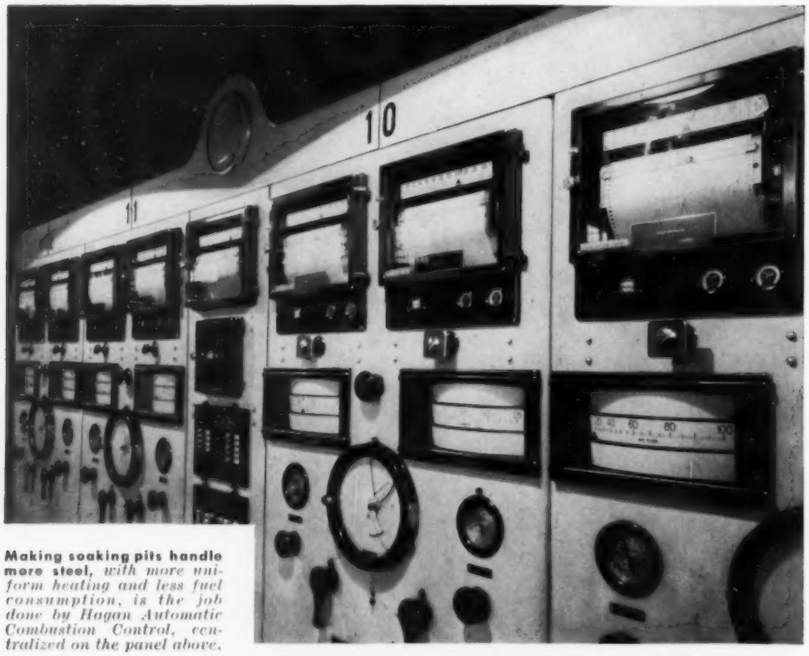
The Rolls with The Red Wabble
They Roll More Tons Per Dressing

higher quality finish

increased production

lower cost per ton

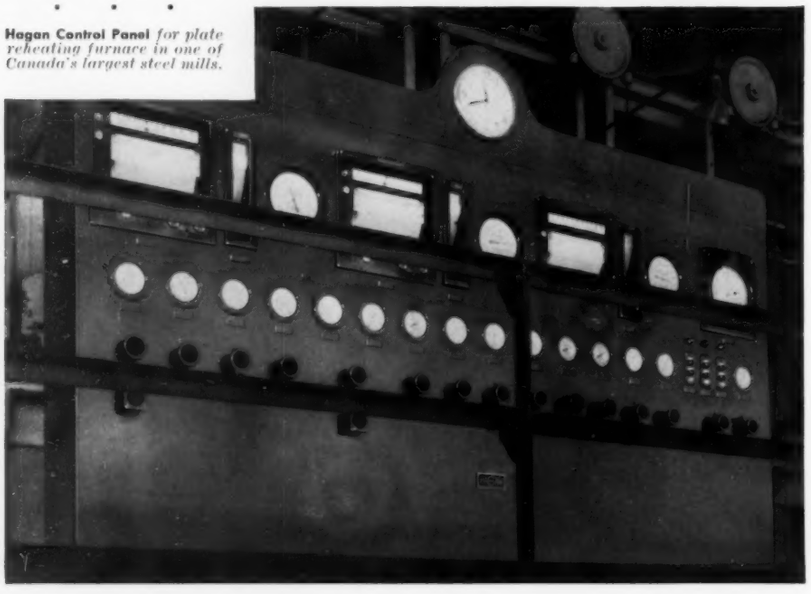
Canadian steel company steps up production with Hagan *Automatic* Combustion Control



Making soaking pits handle more steel, *with more uniform heating and less fuel consumption, is the job done by Hagan Automatic Combustion Control, centralized on the panel above.*

• • •

Hagan Control Panel *for plate reheating furnace in one of Canada's largest steel mills.*



TO meet the ceaseless demand for more steel, a large Canadian producer is utilizing every available means for increasing its capacity.

Heating-furnace inefficiencies – a bottleneck in many plants until relatively recent times—are being overcome through various applications of Hagan Automatic Combustion Control.

Already, five types of Hagan Control are in service, helping to produce *more* steel and *better* steel at lower cost—on soaking pits, open hearths, billet heaters, plate mill furnaces and gas mixers. Blast furnace gas, coke oven gas, and oil are the fuels burned.

Increased fuel efficiency, more uniform heating, higher temperatures and faster melting speeds—in the furnaces under Hagan Control – have lowered production costs, improved steel quality, and what's even more important, *have increased capacity.* For example, on one rod mill installation, where the furnace was the bottleneck in production, a 15% increase in output was achieved with Hagan Furnace Pressure Control.

Air is free, but incorrect proportioning of air to fuel in *your* furnaces may cost you thousands of extra dollars yearly and tons of lost production. If any of your furnaces are *not* equipped with automatic combustion control, get in touch with us at once. We'll send a Hagan combustion specialist to help you step up your steel output and cut down fuel costs. It can be done soon!

HAGAN CORPORATION • HAGAN BUILDING • PITTSBURGH, PA.

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CANADA *Speeds Production* *with* WEAN EQUIPMENT

WEAN EQUIPMENT FOR OFFENSE

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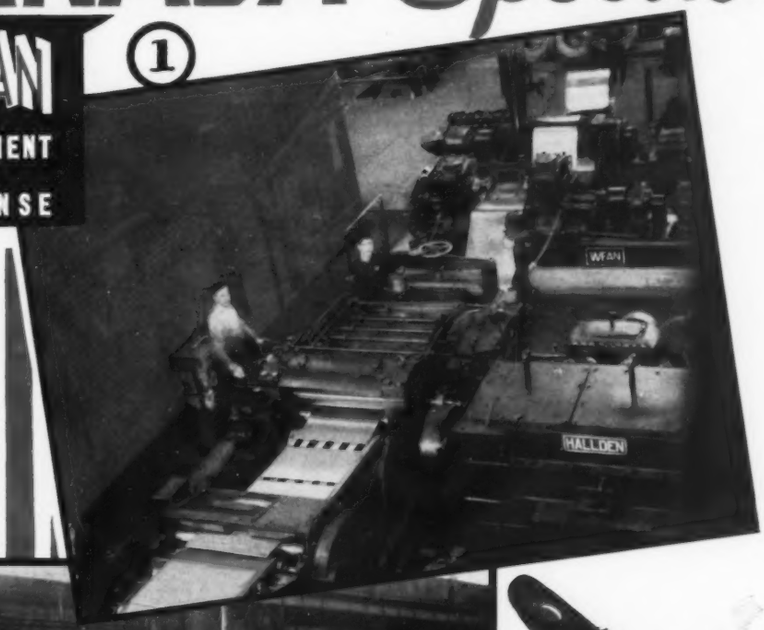
2. Wean Cone Type Hydraulic Uncoiler.
3. Wean Quick Adjusting Side Trimmer.
4. Wean Heavy Duty Roller Leveller For Armor and Ship Plate.
5. 5 Wean Automatic Hi-Speed Tin Plate Coating Lines.



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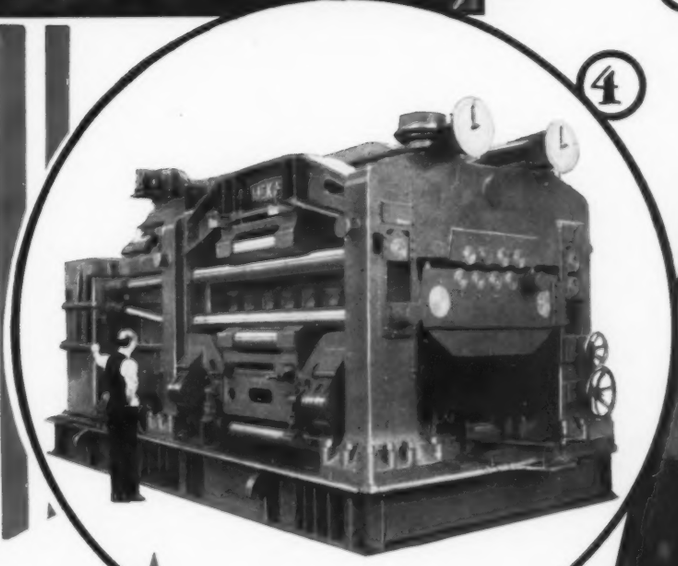
④ 

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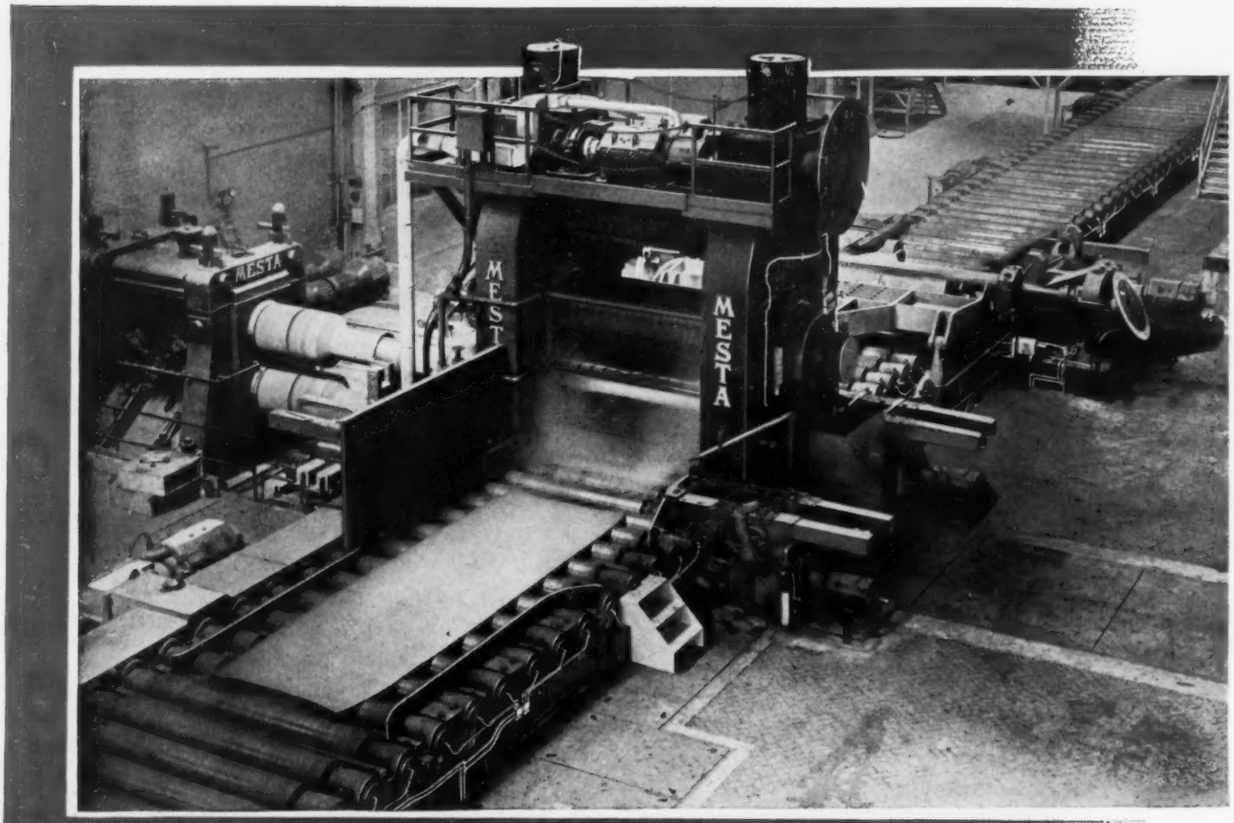

Farval protects the bearings on this 110" Plate Mill

Four full-automatic and five manual Farval Lubricating Systems guard the performance of the bearings on this prominent Canadian Steel Manufacturer's Plate Mill. More than 1,000 bearings receive positive lubrication at regular intervals and—not a bearing is missed.

Another complete Farval installation has been serving the bearings on their 44" Blooming Mill since 1938. There is no time out for lubrication on these Farval-equipped Mills.

The first installations of Farval Systems in the Steel Industry were made more than 15 years ago. Their use has subsequently been extended throughout the steel-producing centers of North America, and England, Scotland, Wales, India, Australia and other countries as well.

An experienced Representative will be glad to tell you how Farval can reduce your costs, increase your production, and pay back your investment within the first few months.

Farval—the Dualine System with the positive Piston Displacement Valve—that is fully adjustable — has but two moving parts—and with a Tell-Tale at each bearing to show the job is done.

The Farval Corporation, 3278 East 80th Street, Cleveland, Ohio.

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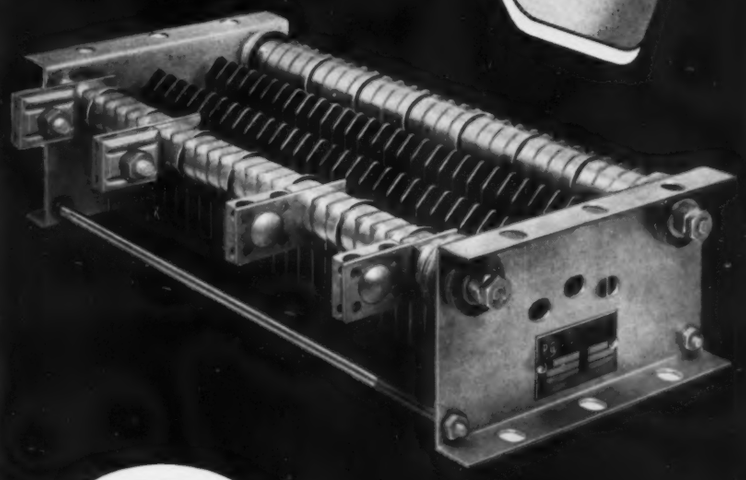

DIFFERENT—because the unique design of the P-G Steel Grid insures even heat distribution over the entire grid surface. Each part of the resistor element is equally exposed to air. Heat produced is rapidly dissipated and resistor can be overloaded without damage or developing hot spots. Where trouble-free, heavy duty service is desired, specify P-G . . . . .

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AVOID SHUTDOWNS

"We increased Production on Our Hoist and Corrected a Hazardous Situation Simply by Installing BUSS FUSES"

Says Mr. HILL .. GENERAL MANAGER
AMERICAN BANGOR SLATE CO.
BANGOR, PENNSYLVANIA

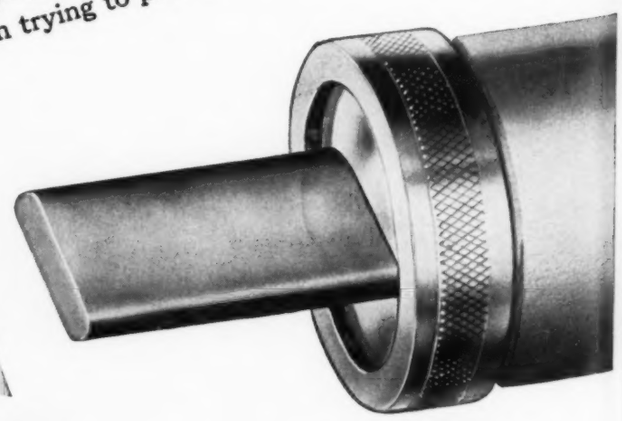
"The hoist we use for raising slate from our quarry is powered by 75 h. p., 440 volt slip ring motor. This hoist raises from five to ten tons of slate at a time, a distance of about 300 feet.

The heavy starting current on the motor formerly caused frequent blowing of fuses. This not only delayed production on our hoist but also frequently created a dangerous situation as we had tons of slate stalled in mid-air.

In the early part of 1941 we replaced the fuses on the motor circuit with BUSS Super-Lag fuses. This change entirely eliminated the trouble we were having with needless blows. It also increased production on our hoist and corrected a hazardous situation.

We are glad to pass this information on to other plant men as it may help them solve a similar difficulty—and today I feel that it is most important that we all cooperate in trying to prevent the waste of any time or material."

H. Hill, GENERAL MANAGER



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...In Your Own Plant

BENEFIT by MR. HILL'S EXPERIENCE

Have you checked lately to be sure that your production is not needlessly interrupted by electrical protective devices opening on ordinary harmless overloads, momentary high starting currents or other temporary current surges? . . . That this condition is not the cause of losing time, wasting money, creating unnecessary delays?

The correct answers to these questions are important to you—today, more than ever—because a fuse is THE vital link that keeps the circuit in operation and often holds the production line together!

If You Have "Shutdown Trouble"— This is How to Cure It

Take a page out of Mr. Hill's book . . . In your plant you can duplicate his experience—just as thousands of other operating executives have done . . . Speaking of the change to Buss Super-Lag fuses, he says, "It entirely eliminated the trouble we were having with needless blows . . . increased production . . . corrected a hazardous situation."

Buss Super-Lag Fuses don't blow needlessly! They provide ample protection on normal loads, plus the additional advantages of the Buss time-lag feature that prevents needless blows when harmless temporary overloads occur under ordinary operating conditions. It is this "delayed action" on reasonable overloads and normal starting surges that saves so many priceless man hours.

Good "Contact" and the Buss 10-Feature Fuse Case Also Reduce Outages

Poor contact is another cause of needless blows. This has been reduced to a minimum with the "10-Feature" Buss Fuse Case—designed to make and *maintain* good contact, as well as hold a fuse-link. When a Buss fuse is assembled or renewed, good contact is automatically made on the link—and is always maintained no matter how long the fuse is in service. This avoids overheating due to poor contact and consequent interruption from needless blows.

Protect Your Plant Against Shutdowns

Guard against avoidable delays, electrical hazards, shutdowns, lost man hours. Specify Buss Super-Lag Fuses wherever electrical equipment needs protection. Send for Bulletin Rcs.

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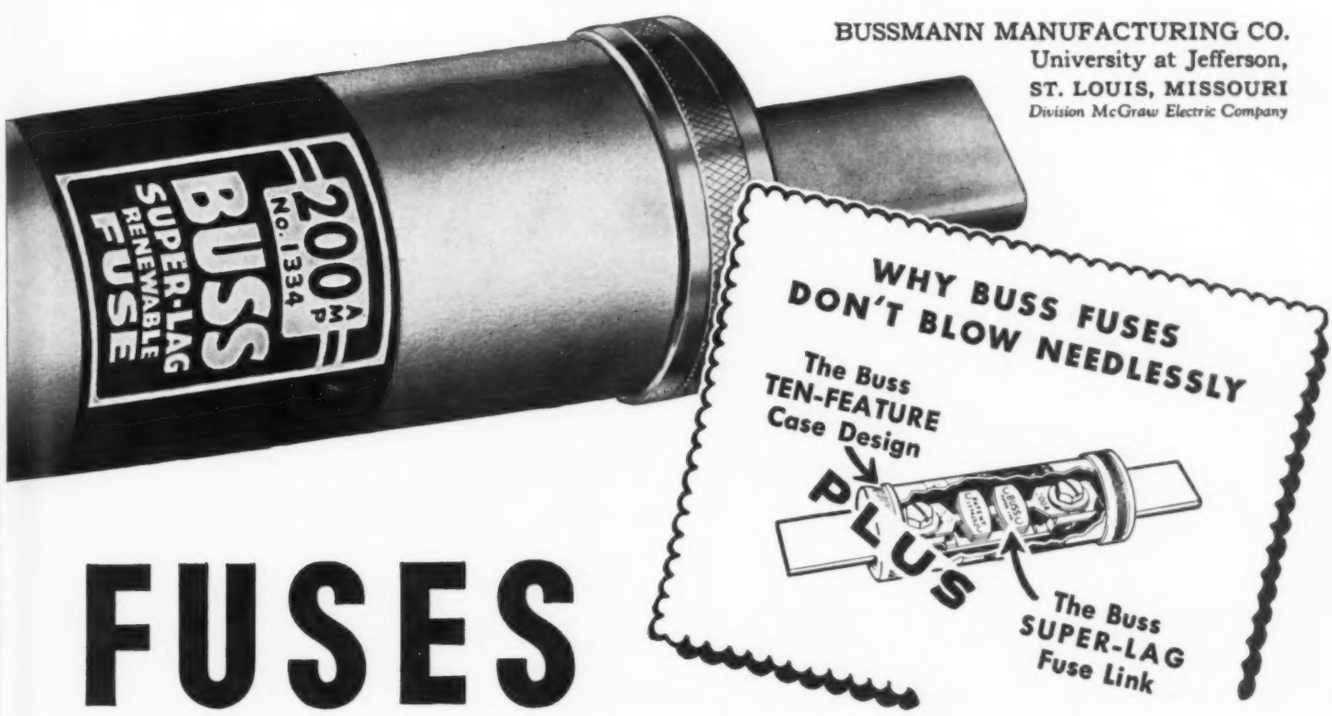

FUSES

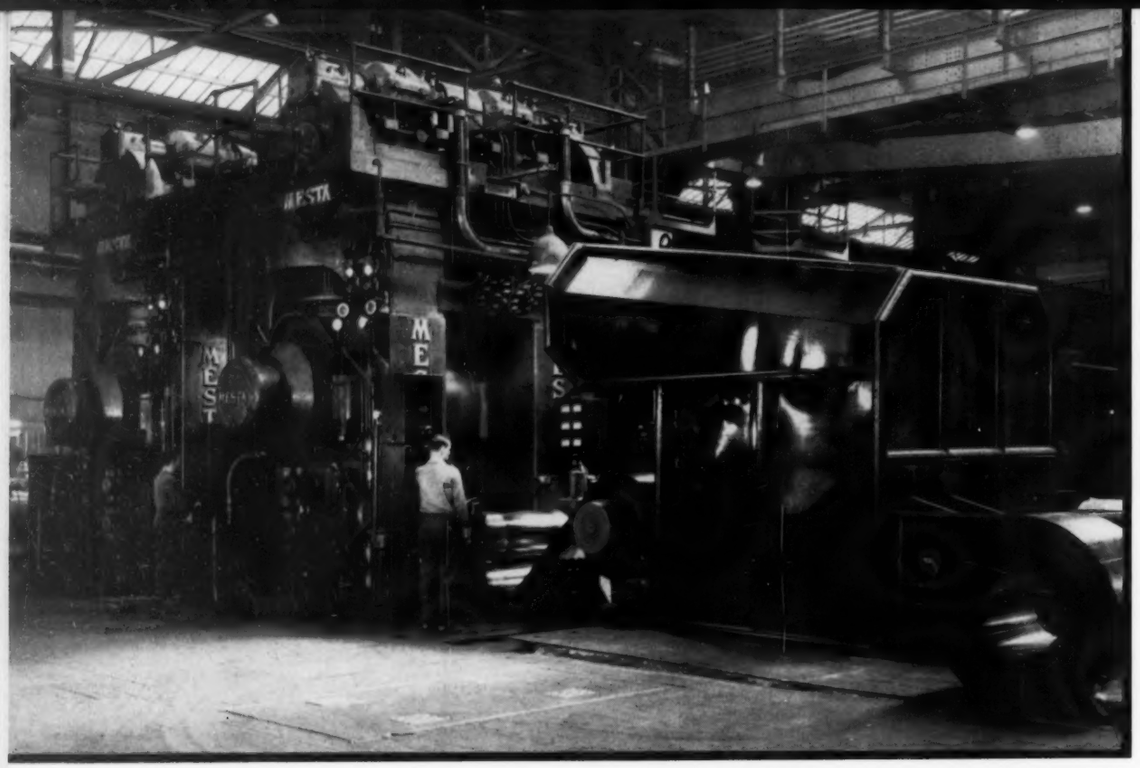

Figure 1 — 42 in. two-stand temper mill.

The TEMPER MILL

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ALLIS-CHALMERS MFG. CO.

Milwaukee, Wisconsin

Presented before A. I. S. E. Annual Convention

▲ TIN PLATE from slab to canner is as good an example of American mass production and precision manufacture as can be found. The menus of 132 millions of Americans, including the armed forces, vary directly with their ability to wield a can opener. It is to this condition that we are indebted for a market steady and large enough to make possible the present heavy investment in precision machinery.

The temper mill of today is as revolutionary as the hot strip mill, and can be considered a by-product of the latter in the move to lower mass production cost. The first wide, hot strip mill was built in 1926. This development was made possible by the introduction of back-up rolls and their correlated parts. The refinement of the modern temper mill by rolling the strip under tension was begun about 1934.

The temper mill is a precision tool operating upon the steel under tension. It is most economical and practical to build this mill in several component parts which must all be precisely coordinated in the operation of rolling strip. Therefore, we shall center most of our attention on its control.

A discussion of this mill covers the processing of steel strip after it leaves the annealing furnace and before it enters the shearing lines and tin house. Being so near the end of the finishing process it necessarily is a mill of intricate refinement. Each reel, tension roll, and stand being a separate machine, both mechanically and electrically, it may be well to picture, in an elementary fashion, the technical relation between the several units as well as their individual characteristics.

Figure 1 is a two stand temper mill showing the following component parts: delivery reel, delivery tension rolls, mill stands, entry tension rolls and entry reel.

In Figure 2, the mill is shown diagramatically with the strip progressing from right to left. The broken lines show shaft connections between each separate component part of the mill and driving motor. All motors except the drag generators on the entry reel are connected to the main generator by a single bus. These drag generators supply power to a separate counter emf generator during rolling. Modern d-c machines can withstand the high overloads during acceleration, and with the Ward-Leonard system, using this connection, the machines may readily be controlled with the required accurate speed ratios between them at any operating speed to maintain the load balance which results in the desired tension in the strip.

It is to be noted that for purposes of illustration, the delivery tension device is shown with a single drive

motor and pinion stand, while the entry tension drive is shown with individual roll drive motors. This combination will be used for the discussion, however, in practice either single motor or individual motors are used for each device. Likewise the drive motor for stand No. 2 is shown connected to the top work roll, and a small motor is shown driving the bottom back-up roll, while on stand No. 1 a pinion stand is used. Both types of drives have been supplied and are of interest. All main drive motors are shown direct connected as is most economical on high speed mills. While it would be of interest to discuss the effect of reduction gears this item warrants separate treatment.

Since the steel comes to the mill from the annealing furnace with a definite, and unsuitable, yield point and a relatively dull surface, the desired surface finish, yield point, and, within limits, granular structure are obtained by a combination of roll pressure and tension. The operation throughout, under steady conditions at various speeds, requires practically constant torque which provides a convenient basis of analysis. This hypothesis is effected by extraneous friction and machine losses.

General Rolling Theory

Considering the component sections of the mill then, and neglecting the relatively small friction, all of the output of the entry reel drag generators produces tension. For any required tension then:

$$T = \frac{HP}{FPM} \times 33{,}000, \text{ where } T = \text{tension in lb}$$

The same is true for the delivery reel and the delivery and entry tension rolls, since none of these devices do work in deforming the strip, their total torque being delivered as pull at the surface.

In all of these devices on recent mills, the motor torque is transmitted to the strip entirely through surface frictional contact on the rolls and reels. On earlier mills the strip was clamped in the delivery reel, which resulted in the loss of costly time in setting up for rolling.

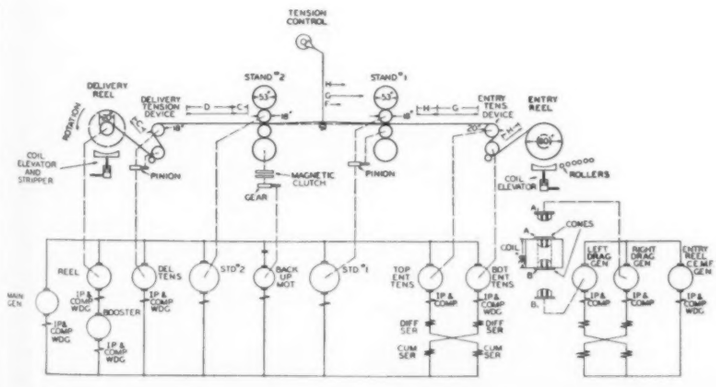
As in all these devices, the entire motor output is used for tension; the input to the motor is measured electrically to give the measure of tension. In a Ward-Leonard system such as shown in Figure 2, requiring constant torque, if the generator voltage is raised with a strip in the mill at standstill, sufficient current will circulate in each motor (assuming armature resistances proportional to motor ratings) to produce the required torque to drive the load. At any generator voltage above this value, each motor builds up a counter emf equal to the generator voltage less IR drop, the current remaining substantially constant. Speed, of course, is then proportional to counter emf, torque varying directly with the product of current and field flux. By calibrating a standard wattmeter to read in proportion to this product, tension in pounds is read directly. It is convenient to do this on the tension devices. On the reels tension is measured by armature current since field flux changes with reel diameter.

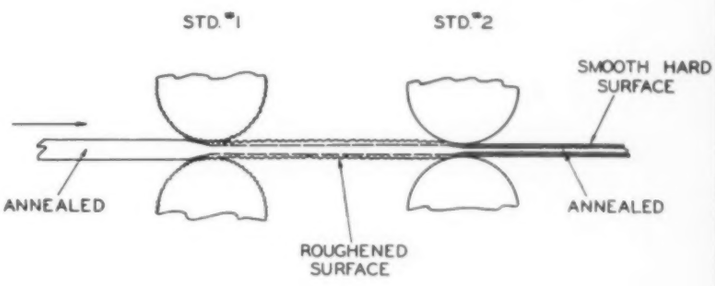
In stands No. 1 and No. 2, however, where work is expended in deformation of the strip and only a small part of motor horsepower may be used to exert tension, other methods must be used to measure such tension, because it is impossible to separate by electrical meas-

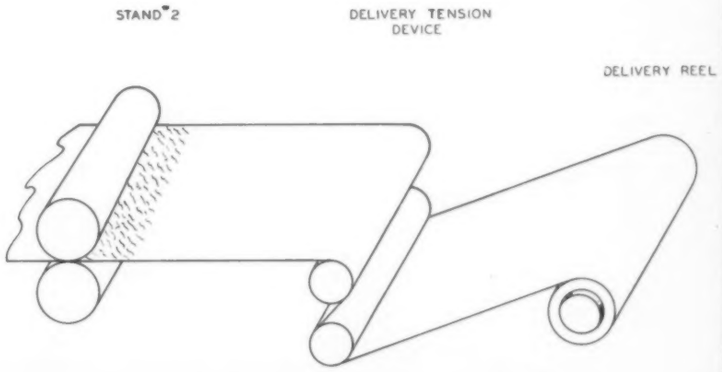
Figure 2 — Diagrammatic representation of a 42 in. two-stand temper mill showing Ward-Leonard system of control. (Below).

Figure 3 — Tempering by roll pressure. (Right)

Figure 4 — Uneven flow of metal under high roll pressure.







urement of motor input, the hp used by roll pressure from that used to exert tension.

From Figure 2, tension C may be seen to be exerted by the delivery reel motor. Tension at the delivery side of stand No. 2 is the sum of the pull delivered by the reel and tension device motors C+D. This tension, of course, is balanced by an equal force consisting of the sum of entry reel tension H, entry and opposite tension roll tension G, that portion of the work done on the strip surface in stand No. 1 not supplied by stand No. 1 motor, and that portion of the work on the strip surface done in stand No. 2 not supplied by stand No. 2 motor, (this value may be either positive or negative) F+G+H. The reel and tension device tension values are regulated to a constant quantity automatically, irrespective of values elsewhere in the mill. Therefore, tension between stands may be varied between wide limits by varying the input to stand No. 1 motor.

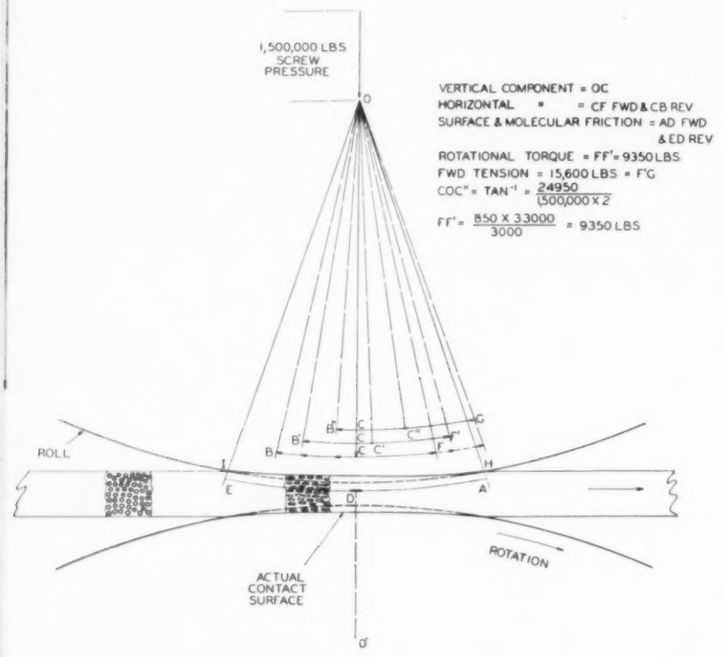
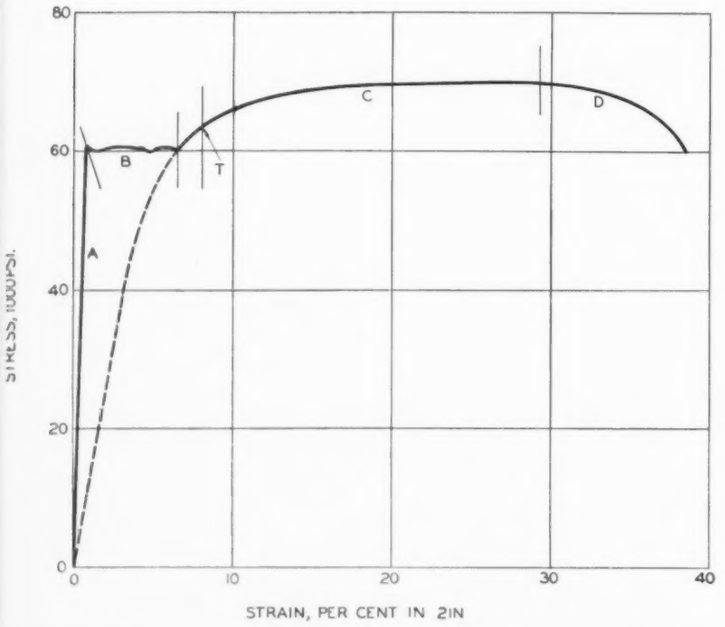

1,500,000 LBS
SCREW
PRESSURE
VERTICAL COMPONENT = OC
HORIZONTAL " = CF FWD & CB REV
SURFACE & MOLECULAR FRICTION = AD FWD
& ED REV
ROTATIONAL TORQUE = FF' = 9350 LBS
FWD TENSION = 15,600 LBS = F'G
COC' = TAN⁻¹ = 24950 / 1500,000 X 2
FF' = 850 X 33000 / 3000 = 9350 LBS
ROLL
ACTUAL
CONTACT
SURFACE
ROTATION

Figure 5 — The action in the pass line of temper mill.

Figure 6 — Typical stress-strain diagram of a dead-soft steel sheet.



For example, if stand No. 1 motor is supplying no hp, all of the work done by stand No. 1 rolls, plus the balance of back tension exerted by the entry tension device and drag generators, is performed by energy supplied from stand No. 2. Greater tension can be exerted by making stand No. 1 a generator. Conversely, if stand No. 1 motor supplied just the work done by its rolls, plus the back tension, there is no tension between stands.

Practice varies greatly among different operators, in securing a similar Rockwell specification and also for different grades of steel.

Table I gives the distribution of power in a mill rolling typical tin plate stock, 27⅛ in. wide finishing at .0091 in. thickness. Column 3 gives the delivery reel tension C, column 5 tension device tension D, and column 6, total delivery tension in lb pull (Figure 2) on the delivery side of stand No. 2. Column 9 shows the difference in forward and back tension in stand No. 2, which, when reduced to hp and added to the hp supplied by the motor, column 7, gives the work done on the strip in stand No. 2, column 8. Column 10 shows that for the two tests the average work done by the motor was 83.9 per cent, the rest being supplied by forward tension. Likewise, column 14 gives the difference in forward and back tension in stand No. 1 and column 15 shows that an average of 61.4 per cent of the roll work in stand No. 1 is supplied by its motor. It will be noted that the entry tension device tension is not separated from the drag generator tension in column 17. On mills where more screw pressure can be used on stand No. 1, more tension is supplied by the entry tension device and a greater percentage of roll work in stand No. 1 is supplied by its motor.

A method used by a number of operators is illustrated in Figure 3 which is exaggerated. The roll surfaces of stand No. 1 are relatively rough for some steels, doing work mostly on the surface of the strip. The smooth polished surface of the rolls of stand No. 2 take out these surface workings, producing a bright, smooth and hard finished surface with the interior relatively soft. This illustrates the resulting action from roll pressure. Normally flat products are tempered entirely by roll pressure. However, it would be well to point out that the Rockwell test indicates only the surface condition of the material.

A slight reduction is taken in stand No. 1. A small extension is thus secured between No. 1 and No. 2 stands and a slight reduction is obtained in stand No. 2. On leaving stand No. 2, there is often indication that the metal did not flow evenly under the high roll pressure. This is pictured in Figure 4.

The action in the pass line is indicated in Figure 5,

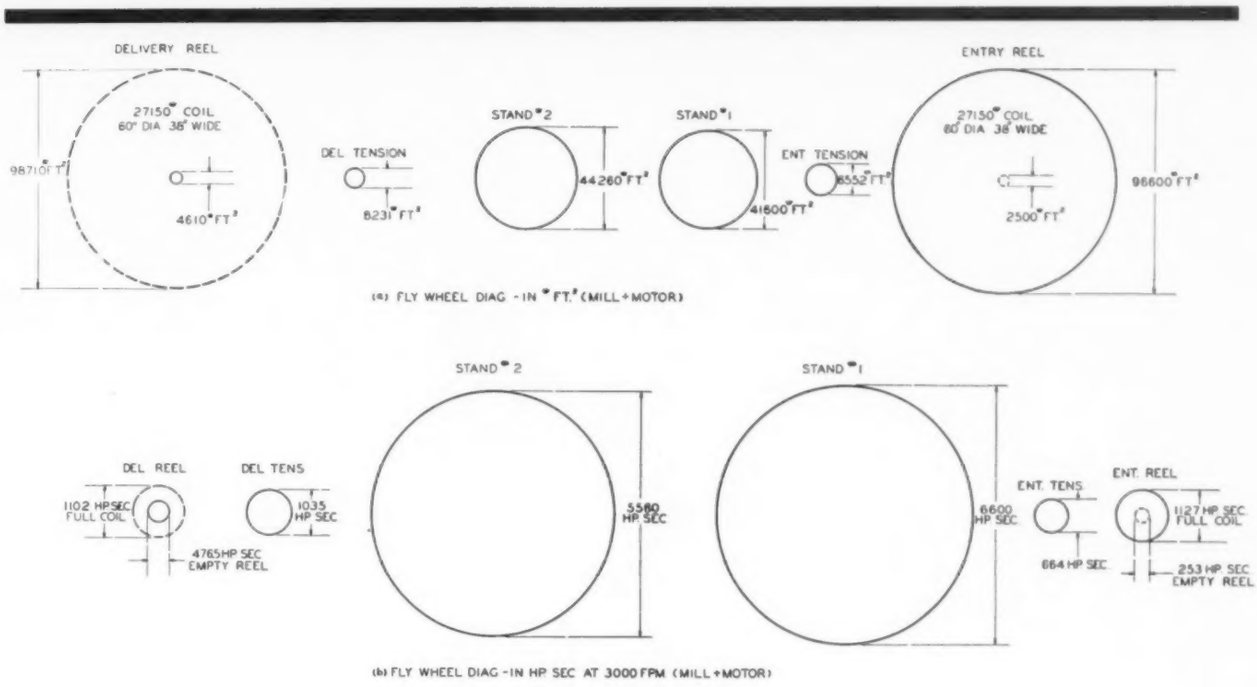


Figure 7 — Relative values of stored energy of mill at 3000 fpm.

where, with the mill at stand still, roll pressure is indicated by line OC. Since the strip is compressed most at the roll center line there will be horizontal components CB and CF tending to squeeze the steel out of the rolls. However, roll surface friction combined with molecular friction in the strip represented by ED and AD is greater than these horizontal components and prevents elongation. This is true at any screw pressure since no lubrication is used to reduce surface friction, i.e., change ratio between screw pressure and surface friction. However, when the rolls are driven, the driving force shown relative in value at FF′ adds to the forward horizontal

TABLE I

			← C →		← D →	← C+D →									← H+G →
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
TEST NO.	FPM	DEL. REEL HP	DEL. REEL #TEN.	TEN. DEV. HP	TEN. DEV. #TENS	TOTAL DELIVERY #TENS.	STD. #2 H.P. (DELIVERED BY MOT.)	STD. #2 H.P. (ROLL WORK)	STD #2 #TENS.	% ROLL WORK SUPPLIED BY STD. #2 MOT.	TEN BETWEEN STD'S	STD. #1 H.P. (DELIVERED)	STD. #1 H.P. (ROLL WORK)	STD. #1 #TEN.	% ROLL WORK SUPPLIED BY STD. #1 MOT.	DRAG GEN. H.P.	ENTRY #TEN.
1	400	15.52	1282	37.3	3080	4362	38.6	45.9	610	84.1	3750	15.44	28.59	1085	54.1	32.3	2665
1	700	29.83	1408	63.9	3018	4426	86.7	95.7	426	90.5	4000	28.45	51.25	1075	55.5	62.1	2925
2	400	16.3	1345	36	2970	4315	38.6	51.5	1065	75	3250	18.0	24.98	575	72.1	32.4	2675
2	700	29.5	1390	63.9	3018	4408	88.9	103.5	696	85.9	3812	31.9	49.95	852	64	62.75	2960
AVG.			1356		3021	4378			699	83.9	3703			897	61.42		2806
LB'S PER SQ IN.			5500		12240	17720					15000						11360

force and shifts the triangle from OBCF to OB′C′F′, thus, the forward force CF′ becomes more nearly equal to AD and the back force is reduced to CB′.

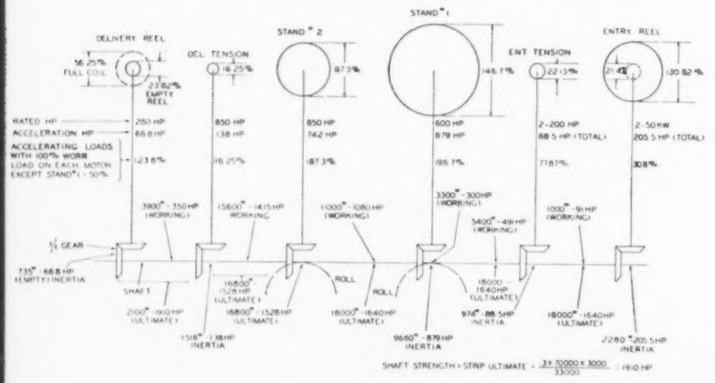
Now, if tension is added, its proportionate value F′G in the forward direction makes the forward horizontal component CG larger than the resisting force AD and the strip stretches.

However, when the strip stretches, due to the unevenness of its structure, it does not elongate uniformly across its area. Further, the elastic limit, or yield point, is exceeded only in the pass line due to the vertical pressure and its horizontal component assisting the tension. Therefore, available forward tension need not be more than 80 per cent of the yield point of the finished product.

The state of the metal is unstable between the yield point and ultimate strength because its total strength is reduced with reduction in cross-section.

If steel is stretched slightly above the yield point by a constant force some slight time is required for it to elongate sufficiently to reduce enough in cross-section to allow it to exceed the ultimate strength per sq in. and unless the ultimate strength is exceeded a point of equilibrium will be reached on the stress strain curve. Further, the strip is only above the yield point of the total cross-sectional area for the exceedingly short time from D to H (Figure 5) and meanwhile roll pressure is being reduced as it travels, thus increasing the yield point. When the structure is strained beyond the yield point, it will pull back to equilibrium as the yield point increases again. Consequently, due to irregularity in structure, unevenness may generally be noticed between the delivery side of No. 2 stand and the tension device as indicated in Figure 4. Tension must, at this point then, still exceed the yield point in the areas of the cross-section unstretched, so that it will continue to elongate until the unevennesses are taken out. As the steel passes over the tension rolls, it is bent slightly on both sides or surfaces further assisting the flattening process and the tension is reduced to approximately one-third, so that it thus is brought back to equilibrium under reduced

Figure 8 — Flywheel diagram — in per cent of motor current to accelerate to 3000 fpm in 15 sec.



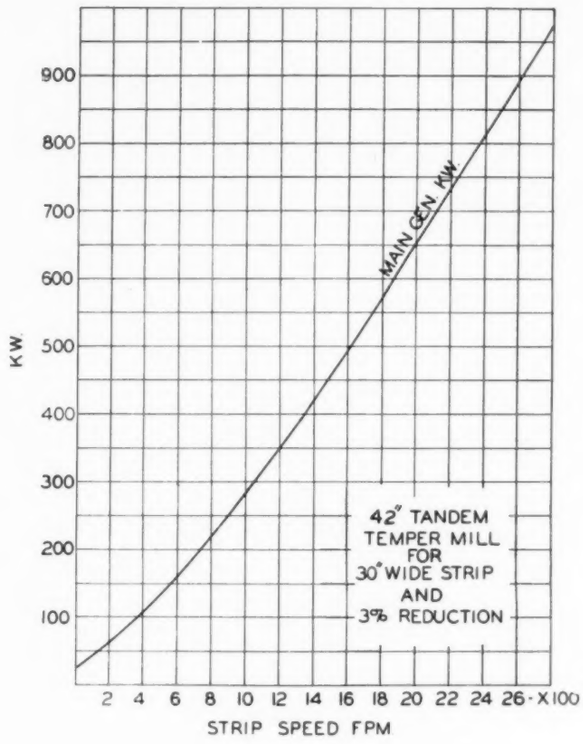
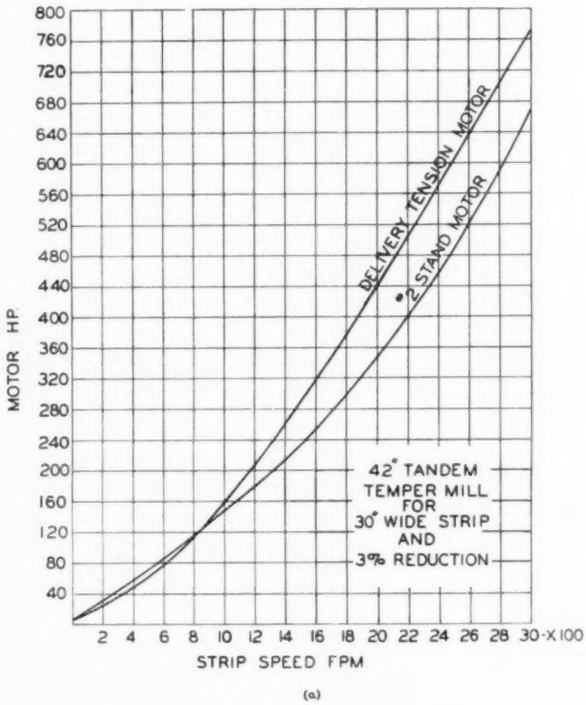


Figure 9 — (Below) Curve showing strip speed in fpm vs. motor hp; (above) Curve showing strip speed in fpm vs. kw.



(a)

tension and becomes a flat strip as it is wound on the reel.

This process is called "pulling through the stretcher strains," or, elimination of the plastic deformation during the yield point elongation. The solid curve of Figure 6 shows the stress-strain diagram for fully annealed strip. Irregular elongation occurs during section B of this curve, giving rise to stretcher strains as seen in Figure 4. To be properly tempered, the material should be stressed approximately to point T of this curve. This, then, changes the stress-strain curve to the dotted line and when subsequently formed in dies the material will stretch evenly.

The rolls then may be thought of as rotating dies with highly polished surfaces to give high finish.

Power Requirements

Suppose that the toughest steel to be rolled has an average yield point of 60,000 psi and an ultimate strength of 70,000 psi after being temper rolled. Suppose further that the average strip is .01 in. x 30 in. = .3 sq in. But the percentage of the strip area remaining unstretched, as it leaves stand No. 2, omits that portion which is corrugated or "wavy." It is judged that this unstretched area will not exceed 80 per cent of the total.

Thus, the required tension at the delivery side of stand No. 2 is 65,000 x .3 x .8 = 15,600 lb tension to give a stress midway between yield point and ultimate.

Delivery Reel — Experience has shown that a ratio of approximately 3 to 1, between delivery tension device, and reel tension, cannot be exceeded to give enough surface pressure on the tension rolls to transmit the required torque without slip. With the ratio 3:1, reel tension must be 25 per cent or ¼ of the total rolling tension. Thus the required reel tension becomes 15,600 x ¼ = 3900 lb or 100 x 3900 ÷ 33,000 = 1.18 hp per fpm or 350 hp for a 3000 fpm mill, and 30 in. wide strip. If we consider the service factor at .8, a motor of 280 hp could be used, with 25 per cent maximum overload during rolling, neglecting friction losses.

Delivery Tension — The remaining tension then, is 15,600—3900 = 11,700 lb or 35.5 hp per 100 fpm on the tension motor for a 30 in. wide strip, or 1065 hp for a 3000 fpm mill, which with a service factor of .8 gives a motor of 850 hp, with 25 per cent overload during rolling, neglecting friction.

Stand No. 2 — The yield point between stands, is somewhat smaller in value, probably 85 to 90 per cent of that in the delivered strip. However, unlike the strip leaving stand No. 2, the full width of strip must be stressed which results in a somewhat higher tension than that produced on the delivery side of stand No. 2 to reach the yield point. Thus, if the value of 85 per cent is used, and the yield point is to be exceeded only at the delivery side of stand No. 2, equal tensions entering and leaving stand No. 2, would cause the yield point to be approached but not actually reached on the entry side, and stand No. 2 motor would supply all work done on the strip by the rolls. Generally the tension on the delivery side of stand No. 2 will be somewhat higher than on the entry side. However, the hp of the driving motor under maximum conditions may supply a tension power in addition to that required to drive the rolls. Good results have been derived by using the same hp rating as supplied for the delivery tension rolls. A margin of power is then available, so that stand No. 2 motor may be used to supply a considerable percentage of the required tension between stands if found desirable.

Back Tension — As stated above, the forward tension must be balanced by a similar back tension.

The size of the drag generators on the entry reel is limited by three factors:

1. Frictional contact between reel cones and inner surface periphery of coil. (See A, B, Figure 2.)
2. Slippage between outer layers on the coil as it unwinds.
3. Torque required to decelerate a full coil in stopping.

As to the first consideration, this value has been limited by the physical contact of wedge shaped cones of the entry reel and in early installations considerable spoilage of the inner layers of the coil resulted in attempting to get sufficient wedge action. On later mills, expanding cones have been developed to give adequate frictional contact and pressure between cones and inner layer of coil.

The second factor is effected somewhat by the degree of tightness with which the coils are wound at the cleaning line, and the sticking between layers caused by carbonization of foreign material during annealing. When sufficient tension is used to create longitudinal slippage between the outside layers as the coil is unwound scratching results which, it is thought, may account for some of the "pin" holes found at times in the finished product. As a result, a tension value of approximately 66.6 lb per inch of strip width has been found a maximum average value.

Drag Generators — This would give 2000 lb tension, or 6.06 hp per 100 fpm, for a 30 in. wide average strip, or 60.6 x .746 x .85 = 3.84 kw for steady rolling, based on a drag generator efficiency of 85 per cent. The question of deceleration will be discussed later. Thus, for a 3000 ft mill, 115.2 kw would be required, which, if a service factor of .8 is used, would result in 94.16 kw and two 50 kw drag generators, or the equivalent of 157.5 hp would be used.

Entry Tension — Using again the ratio of 3 to 1 between tension device and reel, a maximum value of 472.5 hp (.525 hp per 100 fpm per in. width) could be used on the tension device for 30 in. wide strip. To obtain a better distribution in comparative size, however, with stand No. 1, as will be discussed in the paragrap below, 400 hp would be selected or .444 hp per 100 fpm per in. width. If individual drive is used, a 200 hp motor (.222 hp per 100 fpm per in. width) would be connected to top and bottom rolls.

Stand No. 1 — It was stated above that the tension between stands was equivalent to 850 hp at 3000 fpm.

850—(200 + 200 + 157.5) = 292.5 hp.

This means that this value of maximum hp is available in tension between stands to balance back tension and to assist in driving the load of stand No. 1. Stand No. 1 motor size is obtained from test to determine load requirements. Normally, however, this motor size is determined from WR^2 requirements during acceleration rather than from actual load as will be later shown. For the average mill at 3000 fpm, 500 hp or 16.6 hp per 100

fpm would be most probable, with a 30 in. wide strip.

Figure 9 shows hp values for steady rolling conditions. These values are average, both for grades of steel and operating practice, having been taken over a period of years and in different localities. It will be noted that the hp ratings, for the example given here, were selected on the basis of a 30 in. wide strip. The figures, however, were set up for a 42 in. wide mill, which will accommodate a 38 in. wide strip.

Mill motors being rated at maximum speed have normally a 2:1 speed range by field control. At half speed then the torque available is twice that at rated speed.

By setting the motor sizes at top speed for the average width strip being rolled, maximum tonnage will result. When wider strip widths are to be rolled, the control is arranged so that motor fields are strengthened in the maximum ratio of 38:30, or as required, thus giving proportionate increase in torque at reduced speed in inverse proportion.

This is not true of the reel motor and drag generator where all the field range may be required for reel build-up. Here the control automatically varies hp in proportion to speed by changing booster and counter emf generator voltages respectively; this keeps the pull the same for any speed. Sufficient margin should be left in the rating of these machines for the wider strip.

With the present trend toward higher mill speeds and the demand for shorter accelerating times, it is now necessary that mill conditions be more carefully analyzed than was done previously. With short accelerating times, it is possible and likely that flywheel effect may determine the required hp. This factor is greatly influenced by the use of large coils, consisting of two or more 5000 lb coils welded together, thus making flywheels ranging from 12,000 to 30,000 lb out of the reels when coiled full of steel.

That this factor is important, is borne out by considering that the rotating parts of each motor add to the rotating parts of corresponding reel, etc. to make up a flywheel, the effect of which, of course, varies as the square of speed. In Figure 7 (a), the relative sizes of flywheels expressed in lb-ft^2 of all the component parts of the mill (mill parts plus motor) are shown to scale for a typical heavy 42 in. wide mill with motor sizes selected above. This illustrates well the great disparity between the parts or section of the mill.

Since the rotating parts of all sections of the mill do not run at the same speed, a better relative picture is given in Figure 7 (b), which shows the stored energy of each part at 3000 fpm in hp-sec drawn to scale.

The motor capacity required to deliver this necessary stored energy during acceleration can now be determined since this capacity is proportional to time. Mill motors are rated 200 per cent current for one minute, and this short time peak rating may be used.

The speed of the mill is set by stand No. 2 motor. The calculations given in the appendix show that the 850 hp selected as given above to drive the load at rated speed will accelerate the inertia of the load at a constant rate in 13.1 sec at its peak rating. However, the 500 hp motor selected for stand No. 1 requires 17.6 sec to supply the stored energy within its peak rating, with only 50 per cent load current. On modern mills it is considered that a maximum time of approximately 15 sec or less, is required for acceleration to obtain tonnage required for a balanced economy, therefore, the size of this motor is increased to 600 hp giving a minimum time of 14.68 sec within its rating. The whole mill then may be set for an acceleration time of 15 sec.

With this time the per cent full load current in each motor, required during acceleration is given in Figure 8 (calculated as shown in the appendix) as well as hp ratings for 3000 fpm. As indicated the accelerating currents on all other motors fall well within peak ratings, with motor sizes selected for normal rolling load. The entry tension motors and drag generators normally pull backward; therefore, their loads are reduced by the amount of the acceleration pull to maintain normal tension, the strip tension then actually supplying the inertia torque.

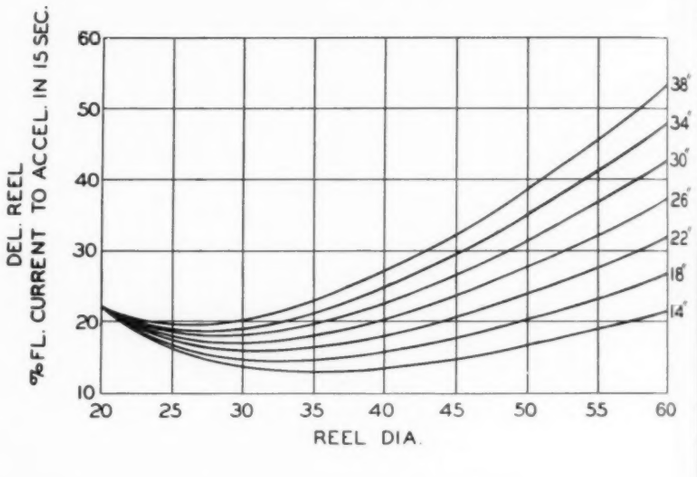


Figure 10 — Curve showing reel diameter vs. entry reel current for deceleration in 15 sec.

Figure 8 gives the relative size of the flywheels to be accelerated as referred to their respective driving motors. It will be noted that between component parts of the mill, the flywheels, drawn to scale, are much nearer comparable sizes with the proper motors applied than in Figures 7a and 7b thus giving a sufficiently well balanced mill. It is most important that this balance be maintained sufficiently so that the machines will have capacity to handle the inertia. Since the various mill parts are connected mechanically only through the strip, the latter may be considered a shaft to which all of these various size flywheels are connected. This enables us to picture the relative requirements of tension and hp in unit values during acceleration.

The delivery reel normal maximum tension is 3900 lb or the equivalent of 350 hp at 3000 fpm transmitted into the shaft. To maintain this tension during 15 sec acceleration, a constant value of hp x 33,000$\div$fpm, equivalent to 735 lb tension or 66.8 hp of acceleration at 3000 fpm, must be added and the maximum motor peak is 416.8 hp. Thus if the value of hp x 33,000$\div$fpm falls below that corresponding to 735 lb, the strip will loop

for lack of tension, all the hp having been consumed in accelerating the flywheel. These values are for an empty reel since this condition prevails normally during acceleration. A maximum of 21,000 lb or 1910 hp at 3000 fpm is required to break the shaft or strip. Consequently, the only worry at this point is a "loop" due to loss of tension. The control then must add just 66.8 hp at top speed and proportionate hp at lower speeds.

In the case of the tension motor, the working tension is 15,600 lb corresponding to combined 1065 hp of the tension motor and 350 hp of the reel. Inertia of the tension rolls and motor requires an added 138 hp equivalent to 1516 lb pull making the tension motor required peak 1203 hp at top speed or 116.25 per cent full load. Since this motor is under regulator control for constant current, the control must cause it to add

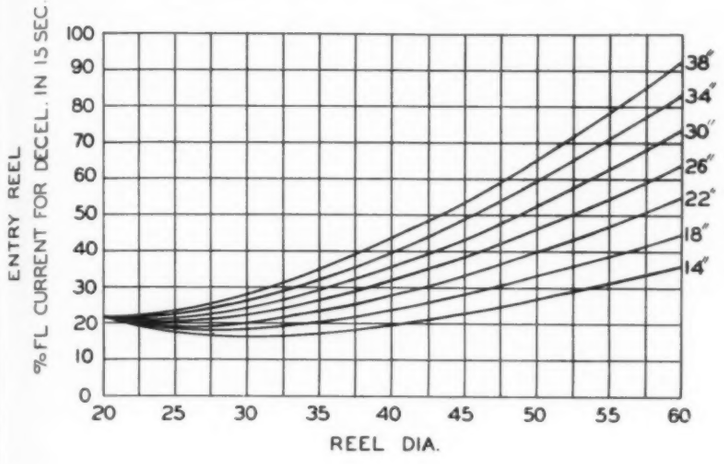


Figure 11 — Curve showing reel diameter vs. delivery reel current to accelerate in 15 sec.

tension equivalent to 138 hp at top speed. This must be done accurately since the working tension is 15,600 lb and the strength of the strip is least in stand No. 2, with 16,800 lb required to break it at that point, only an added 1200 lb or 109 hp at top speed is the margin which cannot be exceeded.

The speed of the mill is set by stand No. 2 which has a set and definite field strength; consequently its current will increase inherently until a value is reached where it accelerates at the rate the generator voltage is being raised.

Stand No. 1 motor must supply a torque equivalent to 9660 lb pull or 879 hp at 3000 fpm to accelerate its flywheel. Referring again to Figure 5, with the rolls rotating, the surface and molecular frictional force ED, which prevents the steel from sliding backward on the roll surface, is forcing it between the rolls. Because of roll pressure, the yield point is probably lower at this point than between stands but taking the same value of ultimate strength as is shown in Figure 8 between stands, with 11,000 lb between stands, the margin below the ultimate of 18,000 lb is only 7,000 lb; therefore, accurate control of accelerating current is absolutely essential. This is particularly true because in the case of steel with cracked edges, the cross-sectional area is reduced at such points and the ultimate is easily exceeded.

As shown, the equivalent accelerating torques of the entry tension device and the entry reel do not approach the ultimate strength of the steel but need accurate control to prevent "looping" due either to too fast acceleration, or extra torque being transmitted to the center of the mill where tension is above the yield point. On acceleration the drag generator load current must be changed from full generator current to 30.8 per cent motor current.

Deceleration — If, during deceleration, the motors from stand No. 1 to the delivery reel have their torques reduced by accurate control by an amount equal to the inertia torque of each corresponding flywheel in Figure 8, the tension will not change in the strip. If too much inertia torque is supplied the strip will loop, and if too little is supplied increased tension in the strip will decelerate the inertia unless the combined load and inertia torques exceed the strength of the steel strip. The entry tension motors and drag generators on the reel (since they pull backward) must have full inertia torque applied quickly on deceleration, (i.e. added to normal rolling torque) otherwise they will decelerate more slowly than other parts of the mill and the strip will loop. There is ample inertia torque capacity in the entry tension motors due to the small flywheel effect. While a liberal size drag generator for normal running tension was selected, it is found that it is the smallest size that could be used to decelerate a full coil. (See appendix.)

Reel Build-Up — The mill stands and tension devices have, for all practical purposes, a constant inertia, being effected by roll wear only. Consequently the inertia compensating torque may be set at a constant value, as calculated above for the rate of acceleration selected, and the control will cause it to be applied automatically as required on acceleration and deceleration.

The reels, however, are flywheels of changing size as steel is wound or unwound. As given in Figure 7a for a 27,150 lb coil, the entry reel changes from an effective 2500 lb-ft² flywheel empty, to one of 96,600 lb-ft² when full of steel, and the delivery reel from 4610 lb-ft² to 98,710 lb-ft² effective. Figure 8 shows that the required motor torques for this inertia are 21.4 per cent empty and 130.8 per cent full for the entry reel and a corresponding 23.8 and 56.2 per cent on the delivery reel. A coil always starts with an empty delivery reel but not always with a full entry reel. Likewise, the operator decelerates at the end of a coil with a varying size coil on the delivery reel but with empty entry reel. Again, when coils are "sticky" or have cracked edges, the operator usually accelerates his mill to a comparatively low speed 50 per cent or less until the bad sections are rolled, then accelerates to full speed; when this takes place, the reel flywheels have changes in size. Furthermore, the flywheels change in size with strip width. Figure 10 shows the required drag generator per cent rated torques for various reel diameters and strip widths from 38 in. to 14 in. Thus, when rolling a 14 in. wide strip, if the control be set to decelerate a full 38 in. wide coil, as it should be required to do, and deceleration takes place at 30 in. diameter, too much torque would

be exerted by 77.3 per cent motor rating or 1340 lb pull. This would be 9560 psi excess in the strip .01 in. thick. Figure 11 shows a similar diagram for the delivery reel. Here, if the control is set to compensate for a full coil the maximum excess pull at 35 in. diameter 14 in. wide strip would be 40.5 per cent motor rating or 1248 lb which would be 8900 psi. From the above relative values in the strip, Figure 8, the strip would break between the tension rolls and stand No. 2.

Obviously for the control to apply the proper compensation, a measure must be had of the varying values of reel inertia. A tensiometer has been used. The objection to this method is the necessity for increased mechanical equipment, cost, and increased length of mill with its consequent waste material at the strip end. Further, if full range in motor speed is placed under tensiometer control, it is difficult to provide the proper compensation to prevent "hunting."

A control has been developed which consists essentially of a motor operated rheostat for each reel controlling motor field strengths, and the position of which is a measure of reel diameter. A switch is provided on the mill housing, with a position for each of the steps in strip width over the range of products to be rolled as given, Figures 10 and 11. The operator then sets this switch to the width nearest to the width of strip being rolled and the inertia torque is automatically changed as the reel diameters change in accordance with the corresponding curves in Figures 10 and 11.

Discussion of Control Features

The control circuits for a single stand mill are shown in Figure 12 and for reasons of simplicity include only the entry tension device, stand, delivery tension device and delivery reel.

Only details sufficient to set forth the most pertinent features mentioned are given.

Tension Devices — As shown in this figure both entry and delivery tension devices have individual motor drives for top and bottom rolls. The load current is balanced between the two motors by cross-connected differential and cumulative series fields while the shunt fields are controlled as though they were a single field by being connected in parallel through balancing resistances R9 and R10 for equalizing adjustment; thus each pair of tension motors is treated as a single motor in the control scheme.

Constant Current Control — Tension is controlled in the tension device motors by controlling for constant current with the added requirement on the reel motors of the field flux controlled proportional to the diameter on the reel; the latter subject will be treated separately. This control function is accomplished by rocking contact regulators 11 DT and 11 ET on the delivery and entry tension devices. These regulators for controlling shunt field current are smooth and stepless in this performance and are solenoid operated.

Constant current is maintained in the reel motor by an exciter which operates on the booster in series with the motor.

Exciter — In analyzing the operation of the exciter, we find that a small separately excited low voltage control exciter CE is connected with its voltage opposed to interpole voltage. The low resistance control field of the exciter is connected in this circuit in such a manner as to be responsive to any difference between the voltage of CE and interpole voltage.

If the control exciter voltage is set for the voltage corresponding to an interpole drop representing full load current, and the actual momentary current and interpole voltage is below this value, a current flows through the exciter control field in the direction to lower exciter voltage and therefore booster voltage, and thus the motor current increases. This action continues until the interpole voltage equals the voltage of CE at which point the motor current is correct and zero current exists in the exciter control field. Consequently when this condition is obtained its voltage ceases to change.

If motor current is momentarily too high, current flows in the reverse direction in the exciter control field and reverse action takes place. Thus the machine regulates the interpole voltage to a value equal to the voltage of control exciter CE.

Mill Speed Control — When tension is applied, the reel and delivery tension motors pull forward while the entry tension device pulls backward. The regulators hold this pull constant irrespective of speed by operating on machine shunt fields to vary motor torques and thus the pull. All motors are connected in parallel to the main generator. The field of stand No. 2 motor is set at constant value, and, therefore, this motor determines the speed of the mill for the other motors all pull forward or backward from stand No. 2.

With the field of this motor set for maximum speed, the mill runs at maximum speed with maximum gengenerator voltage, speed being controlled by generator voltage. As mentioned above this condition is set for average width strips. For a maximum width strip switch K is closed, increasing stand No. 2 motor field. Thus motor torque is increased proportionately not only on the stand motor but automatically on the tension device by means of their regulators.

Inertia Compensation (Tension Devices)

In controlling mill speed the generator voltage is varied by motor operated rheostat RH1 in the generator shunt field which is set to accelerate the mill in 15 sec. Each regulator has a WR^2 coil as shown which when energized changes the value of the current which the regulator holds on the reel; the control exciter CE has an additional shunt field for WR^2 which changes the voltage of this machine when energized. When RH1 is operated to change speed these coils are all energized in the proper direction to add current and torque on acceleration and subtract it on deceleration for the motors pulling forward. No special WR^2 control is required on stand No. 2 motor since this will inherently assume the required load current and inertia current.

Reel Tension Control — As previously stated the load current in the reel motor armature is regulated to a constant value by the exciter. However, since torque must increase in proportion as the reel diameter builds up to hold tension constant and this torque is proportional to the product of the armature current and field flux, with constant current the flux must vary directly with diameter. But with an increase in field flux the speed is reduced correspondingly. The speed,

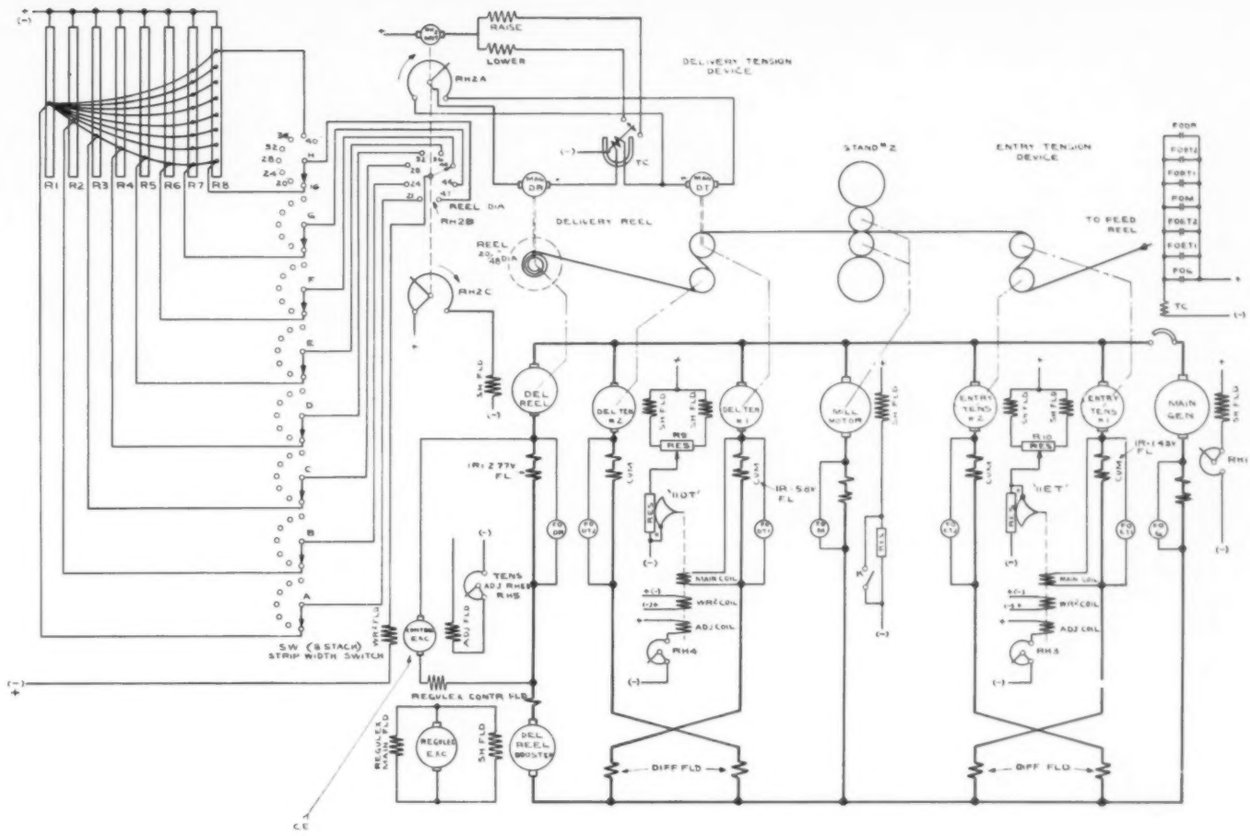


Figure 12 — Schematic diagram of single stand temper mill control.

however, is fixed in its changing value by the strip. As the strip winds up it makes the delivery reel motor run slower and slower. Thus since we can measure speed accurately if we increase flux in direct proportions as speed decreases in the relation $\phi = 1/5$ K, tension will be held constant. (ϕ = field flux, K = a constant.)

To accomplish this a magneto (Mag DT) is connected to the delivery tension device whose voltage is a measure of strip speed. A similar magneto (Mag DR) is connected to the reel motor which measures reel speed. Between these magneto tachometers is connected a potentiometer, section RH2A of a motor operated rheostat, which is controlled by a polarized current control element TC also connected in the same circuit. The operation is such that TC controls rheostat motor RH2 to keep the potentiometer voltage of RH2A equal to the reel tachometer voltage. Thus if the reel builds up to 10 per cent, TC runs RH2A 10 per cent of its travel, at which point the circuit is again balanced. On the same rheostat shaft, section RH2C of the rheostat is in the reel motor field and increases flux 10 per cent. Thus flux varies inversely with reel speed to hold constant tension.

Reel Inertia Control — This method of control provides a very convenient means of accurately compensating for reel inertia with varying diameters and strip widths. On the same rheostat shaft as the tension control sections is an inertia compensating section RH2B. Since the movement of this rheostat is a measure of reel build up, the arm of this section moves proportionately in the clockwise direction as diameter increases. In Figure 12 compensation is changed in steps from 21 in. to 47 in. in diameter. To the left of, and in series with the rheostat section, is a multi-section switch SW with taps from 16 in. to 40 in. strip widths which the operator sets corresponding to the width he is rolling. Suppose it is set for a 16 in. width. At the upper left of the figure, WR^2 curves similar to Figure 11 are reproduced. Resistance R1 is of such a value as to energize the control exciter WR^2 winding to produce 50 per cent added current on acceleration. When the reel builds up to 24 in. diameter RH2B moves to that corresponding tap inserting resistance R2 to set the value of the WR^2 field according to this point on the lowest WR^2 curve. With further reel build up the other points on the curve are connected in sequence. For any other strip width switch SW is set for the nearest corresponding value and as the reel builds up RH2B connects the points of resistance R1 to R8 in sequence, corresponding to the curve of required accelerating current for that particular strip width.

Flashover Protection — It will be noted that a protective trip coil is connected across the interpole of each machine, for instance FOG, for the generator FO-ETI, etc., for the motor. Should any commutator flash over all other machines would feed into the fault since they

are all in parallel. A relatively high voltage is induced across the interpole under such conditions instantly and this voltage energizes the protective relay coils to disconnect all machines and open the generator field.

Conclusion

In conclusion, it is felt that the hp values ascertained above are sufficiently liberal to meet the most exacting requirements of present methods and varying qualities. The intention has been to cover the points of most apparent interest to operators and engineers. Necessarily many items such as those mentioned at the beginning, and others, for example; effect of mill speeds and gear ratios on reel inertias, should be included in a comprehensive study. The analysis of the mill has been made entirely from tension since values of roll pressure were not available. We have, in picturing the rolling method, neither intended to project a dogmatic system, not has the method used in any particular mill been described. As is well known, the set up of rolling procedure in a mill sometimes changes from shift to shift with equally good results. It has been said that the art has preceeded the science, and if by this analysis thought and study be furthered, our object will have been accomplished.

I gratefully acknowledge the help and encouragement given in the preparation of this article by Mr. John F. Sellers, who has collaborated in the work from the beginning, Mr. T. H. Bloodworth, who prepared some of the data, and Mr. D. S. Mortensen, who assembled the manuscript, and others.

In these troubled times much has been said inferring that something is wrong in our country. Our associated engineering fraternities have given considerable space and thought to the problems of large scope in our industries and their result upon the nation. As a nation preparing for a supreme test let us not allow ourselves, as you in the steel industry have not, to say that we in America have any problems which cannot be solved by properly directed energy and courageous perspective.

It was not an accident that high speed production of a container, with the thickness of a visiting card (.010 in.), having a coating 1/40 as thick as the diameter of a human hair (.00008 in.) and selling, on the average, for about 2 cents, came into being.

In 1890, we imported 320,000 long tons of tin plate and produced none. In 1891, the tin plate industry was begun in the United States by virtue of a protective tariff. Twenty years later in 1911, we supplied our own needs using 700,000 long tons. In 1935, we produced 1,850,000 long tons and supplied 20 per cent of the world's export trade while Great Britain was supplying 51 per cent and Germany 19 per cent. Our contribution was 132,276 long tons or 7.15 per cent of our production which went to our neighbors to the South, Japan, Russia and China with volumes in the order named. But in 1935 temper mills were just in the beginning of their present state of perfection; delivery speeds were in the order of 600 fpm compared with approximately 3000 fpm maximum today, and, therefore, resulting possibilities should be somewhat commensurate.

It may be assumed that many of those whose coordinated efforts have been responsible for this development, will be required to help think through our national problems. I believe in a greater America because I believe in the men in it, typified by this example in development, who have met their problems squarely and refused to accept anything less than a solution.

Appendix

3000 fpm

(1) Stand No. 2 — Sets mill speed
(Motor direct connected. 18 in. rolls new, 16 in. rolls worn)

$$\frac{\frac{3000}{18\pi}}{12} = \frac{3000}{4.71} = 637.5 \text{ rpm motor}$$

Mill WR^2	38,000
Motor WR^2	6,260
Total	44,260

$$\text{Stored energy} = \frac{44{,}260 \times (637.5)^2}{3.23 \times 10^6}$$

$$= 5560 \text{ hp-sec}$$

$$\text{Acceleration time} = \frac{2 \text{ av} \times 5560 \text{ hp-sec}}{850 \text{ hp}}$$

$$= 13.1 \text{ sec. (assuming 100 per cent acceleration current and load)}$$

$$\text{Per cent full load current to accelerate to 3000 fpm in 15 sec} = \frac{2 \times 5560 \times 100}{15 \times 850}$$

$$= 87.3 \text{ per cent}$$

(2) Stand No. 1 — Maximum speed
(Motor direct connected)

New rolls stand No. 2, zero reduction, worn rolls stand No. 1.

$$\frac{\frac{3000}{16\pi}}{12} = \frac{3000}{4.19} = 716 \text{ rpm motor}$$

Mill WR^2	38,000
Motor WR^2	3,600
Total	41,600

$$\text{Stored energy} = \frac{41{,}600 \times (716)^2}{3.23 \times 10^6}$$

$$= 6600 \text{ hp-sec}$$

$$\text{Per cent full load current to decelerate full coil in 15 sec} = \frac{2 \times 1127 \times .746 \times .85 \times 100}{15 \times 2 \times 50}$$

$$= 95 \text{ per cent}$$

DISCUSSION

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A. F. KENYON, Steel Mill Engineer, Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pennsylvania

CHARLES H. MANION, Vice President, Follansbee Steel Corporation, Follansbee, West Virginia

T. B. MONTGOMERY, Electrical Department, Switchgear Engineering Section, Allis-Chalmers Manufacturing Company, Milwaukee, Wisconsin

J. S. MURRAY: The paper has disclosed, among other things, the marked effect which the development of the modern-variable speed d-c motor has on rolling speeds. For example, in 1928 the speeds were 400 fpm; in 1939 they were 1800 fpm, and today we find examples of 3800 fpm. With such tremendous increases in production speeds it is little wonder that we in the steel industry are very much concerned with the complicated equipment which we find in our lap, so to speak, on modern mills in order to maintain uniformly constant tension during acceleration, top speeds and de-celeration of such mills. It makes little difference what names we assign to the methods used to attain this condition. The fact remains that it is very necessary for the manufacturers of such equipment to exert their very best efforts towards simplification of this tension control equipment as soon as possible.

Naturally, with such tremendous increases in rolling speeds in such a short time, we realize that the electrical manufacturers have performed a splendid job and we certainly hope that they will now turn their attention to relieving us operating engineers of at least some of the complications which we have inherited in this rapid field of development.

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Bulletin No. 4 International Tin Research and Development Council.

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Sheet and Strip Steel for Deep Drawing Purposes—Joseph Winlock, *Iron and Steel Engineer*, December, 1936.

A. F. KENYON: Mr. Montgomery's paper is one of the first to deal with the electric drives and control for strip temper mills, and Mr. Montgomery is to be congratulated for his analysis of some of the factors affecting the performance of such mills.

The analytical study in the paper is based on a typical 42 in. wide mill to operate up to about 3000 fpm max speed, and the various motor ratings have been arrived at by assuming certain tension values at different points in the mill. It may not be amiss to point out that some mills roll with appreciably lower tensions than specified in the paper, hence are able to operate with motors and drag generators of much smaller ratings. It should be emphasized that there are wide differences of opinion among operating men, and even of the operating technique among different crews in the same plant, and that the capacity of the machines and operating features of the control must be selected to meet the operating practice of the particular plant.

Mr. Montgomery has described a system of current regulator control to regulate the tension at each point in the mill, and has pointed out the necessity for recalibration of the current regulators during acceleration and deceleration, in order to compensate for inertia and maintain the tensions as nearly constant as possible. Uniform processing of the strip requires the accurate maintenance of constant tension at each point in the mill; further as pointed out by the author, the tension at some points may be just below the breaking strength of the strip so that even relatively small tension changes may cause strip breakage. Accurate control of tension is therefore a vital essential to the successful operation of any temper mill. Several mills have installed automatic regulating tensiometers between stands of the mill, also between the entry tension device and the No. 1 stand, and between the No. 2 stand and the delivery tension device. These regulating tensiometers control the entry and delivery tension device motors and the No. 1 stand mill motor, so as to maintain the desired tensions on the strip entering the No. 1 stand, between No. 1 and No. 2 stands, and leaving the No. 2 stand, throughout the threading, acceleration, normal running, and deceleration cycle, and without the necessity for any adjustment or compensation to meet the variable conditions caused by different width of strip, weight of coil, diameter of rolls, rate of acceleration, etc. The tensions between the unwinding reel and the entry tension device, and between the delivery tension device and the winding reel, are much lower than at the points in the mill itself, and are less critical as affecting the quality of strip, so that some variations may be tolerated, and current regulator control of the unwinding and winding reels is satisfactory. Even though the reel tensions vary slightly the tensiometers control the tension devices so that the tensions on the strip entering and leaving the mill are maintained constant.

Mr. Montgomery has mentioned that on some mills the upper and lower rolls of the tension devices are driven by separate motors, to permit slight relative rotation and thus assure smoother "tracking" of the strip. He also mentions that the upper and lower roll motors are of the same rating, and the diagram of connections, Figure 2, shows the arrangement to assure equal division of load between the two motors, (or drag generators in the case of the entry tension device). The strip tension between the mill and the upper tension roll is greater than between the reel and the lower tension roll, so that

with the greater average pressure between the strip and the upper roll, more power can be transmitted from the upper roll than from the lower roll. At least one temper mill has been installed with a large motor on the upper than on the lower tension roll, and the control on some other mills is arranged to permit unequal division of load between the upper and lower roll motors.

CHARLES H. MANION: The remark was made that oftentimes best operation can be secured by the operator's "making allowances" and operating in a manner different from that which the designer of the mill and the control intended, and thus get better results. This does happen and would seem to indicate some "departure from intentions" in the control application.

Most of you men, at one time or another, have been designers and worked right on the board. You have designed at times auxiliaries which you put in operation in the mill and which, in your mind, should assist, and you could foresee results from it. You went out in the mill, and in spite of the way you thought and fought to make it work, the operator got pretty poor results from it, and later discarded it and got better results without it.

When all these things are carried through design board, laboratory and testing floor, they are not worth much unless an operator—and I mean a good intelligent operator—can secure quality production. As Mr. Murray has indicated, there are a great many of these devices that, by means of charts and theories, theoretically improve the operation of a cold strip mill or a temper mill, but to get the best results in quality and quantity production the operator has to operate in some other way.

Under any name, these tension control devices (and I don't say it can't be overcome—I would say it will be overcome) are dealing with almost infinitesimal current regulations that under present conditions and with present equipment appear to be unmanageable in actual operation. The principle is there, but it is a great deal like trying to guide an elephant with a silk thread.

This isn't offered solely in the spirit of criticism. The trend is good, but as has been said, we are at best not more than to the half-way point of developing this equipment to where it will actually do its everyday duty—not simply illustrate a theory illustrated by a graph, but actually help the man on the mill to make more and better steel, especially with reference to shape and to gauge.

T. B. MONTGOMERY: I have very little to add, except that Mr. Kenyon brought out two very good points which should have been emphasized, and I believe were in the paper.

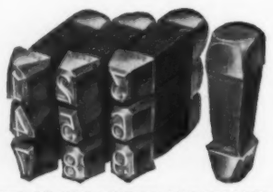
One is the use of the tensiometer on the reel to take the place of what on the slide seemed to be quite complicated. The system shown seems quite complicated from a diagram standpoint, but actually the equipment is considerably cheaper, requires less space and uses less material than the tensiometer. Our group has a tensiometer applied to a delivery reel which has as yet not gone into service. I believe that would be one of the points of interest to some of you.

Another point was the question of motor drive and problems on tension devices. That is something which I certainly believe will bear more investigation and a little more study. I know that at times it has been a bit of a headache.

Now, just one further point in connection with what Mr. Manion had to say. It sometimes has been a marvel to me to walk into a plant and see a combination of diagrams which would cover perhaps the whole side of a room, generally prepared by various companies. That steel mill engineers and maintenance men do become familiar with different systems that seem as complicated as these seems marvelous to me.

I might, however, offer just one little reflection. In the old days, when we had a hot mill, I understand eight men would turn out perhaps 8 tons of steel in 8 hr. In other words, the limiting factor was the human element. Now, you know perhaps better than I do what you can turn out today. Let's say 600,000 lb in 8 hr with three men, not counting electrical men, and we electrical people don't count very much anyway. But in accomplishing that increased production, it seems to me that the most important factor has been the designing around or eliminating of the human element naturally adding equipment. I believe that the mill operators can help the rest of us lick the problem of better quality of production by better quality inspection and maintenance.

SAFETY WEDGE GRIP



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The DESIGN and OPERATION of a MODERN SINTERING PLANT

By M. F. Morgan

REPUBLIC STEEL CORPORATION

Cleveland, Ohio

Presented before A. I. S. E. ANNUAL CONVENTION
CLEVELAND, OHIO

▲ THIS paper on the design and operation of a modern sintering plant is not a technical paper, but is based on data that has been gathered by the writer from actual operating experiences and conditions that have been encountered over a period of years from many different sintering plant operations.

Every operating man always has his own ideas on how he would build a plant and they seldom conform with those of the designing engineer, but usually the operating man's ideas are hindsight while the engineer's must be foresight. In writing this paper I have tried to show some of the things that stand out as absolute necessities to make a sintering plant a low cost operating unit. I hope some of the things pointed out will be beneficial to members of this Association if they are anticipating installing or remodeling a sinter plant.

The design and operation of a sintering plant go hand in hand as no plant can operate on an economical basis if the design is not right. Therefore, everything depends on proper design.

The designing engineer should first investigate numerous operations and take advantage of all the mistakes in design that have been encountered by the operators and try to eliminate as many of them as possible. Lack of thorough knowledge of sintering and what conditions arise in actual operation are the principal reasons for faulty design. We all know that bigger and better plants can be built with closer cooperation between the engineer and operator.

The first thing that governs the design of a modern plant is thorough knowledge of all the raw materials that are available or can be made available for the sintering operation. No sintering plant should be built to handle flue dust alone. The supply is limited and the operation irregular and very costly. The excess carbon, which is fuel that is in the flue dust, should be utilized to sinter fine ore as this method will give the sintering plant carbon control in the feed to the sintering machine, thus increasing the tonnage and lowering the operating cost. The percentage of ore added, to take care of the excess carbon that is in current run flue dust, will increase the tonnage of the plant by the per cent added over the tonnage that will be made by sintering flue dust only. The sinter product will be more uniform and sintering temperatures will be lower. Most sintering plants are built in connection with blast furnaces and as every furnace plant has an abundance of fine ores, some of this ore should be made available for sintering.

The handling of blast furnace sludge from gas cleaning equipment should receive major consideration in the design of a modern sinter plant. Careful checks on different blast furnace plants show that from thirty to fifty per cent of the flue dust produced, comes from the gas cleaning equipment in the form of sludge. The pollution of rivers and lakes is a thing of the past and certainly the recovery of this dust and converting it into sinter helps increase the efficiency of the furnace operation. The method that is employed to recover the sludge for sintering is very important as the sludge is not a desirable sintering material but if handled properly can be added to the other sintering plant materials without difficulty.

The design of a modern sintering plant, after all raw materials have been carefully studied, incorporates five major points: location, bin system, size, cost (initial investment), operating cost.

Location

The location of the plant is very important and should be at the most advantageous place available and not, as many plants have been located in the past, as far away from every other operating unit as possible. A modern sintering plant can be designed that is not a dust hole and the supervisory force should be able to take any one through it without apologizing for its dusty condition. By proper design, most of the dust can be eliminated, but a great deal depends on just how careful the blast furnace operators condition the flue dust at the dust catchers. We have all seen furnace dust catchers dumped at many plants and the cloud of dust that arises would shame even a sintering plant. It is almost impossible to handle hot, dry dust at the sintering plant — therefore, the design of a modern plant

should include the proper flue dust conditioning equipment on the dust catchers at the furnace so that when the flue dust is rehandled at the sintering plant, a minimum amount of dust will be made.

Bin System

The raw material storage bins and automatic feeding equipment that supply the feed to the sintering machine, should receive much consideration in the design of a plant. A sintering plant will not be a success without ample storage capacity and mixing facilities so that definite proportions of raw materials can be maintained in the feed to the sintering machine at all times. The bin system must be designed not only to supply uniform feed, when the raw materials are in their natural condition, but take care of any abnormal conditions to which the raw materials may be subjected. A sintering plant will not produce a uniform sinter unless the mixture of materials is right in every respect. Irregular raw material feed is the cause of most of the difficulties in sintering. Let me emphasize again the importance of a bin system and feeding equipment that will give a uniform feed to the sintering machine at all times.

Size

The size of a sintering plant depends on three things: raw material available, amount of sinter required for a given operation, and the sintering characteristics of the materials to be sintered. The fact that every material has a definite sintering time is often overlooked, which is the cause of many plants never producing the expected tonnage. Tests made on materials to determine their sintering time are not always duplicated in actual operation. Therefore, care should be taken that the sintering plant is of ample capacity. It is desirable that the plant be designed for maximum tonnage and then run on a reduced schedule during slack periods, but this is not always possible, so care should be taken that the plant is located where expansion is possible if larger tonnage is desired. Past experience encountered is that no plant has been built that has excess capacity. During reduced furnace operation periods the percentage of sinter is increased in the furnace and the sintering plant operates on a full time schedule. The difference in the cost of a large plant and a medium size plant is comparatively small, as all auxiliary equipment costs practically the same.

Investment Cost

The initial cost of a sintering plant depends on prevailing prices, where it is located, and what is included in the design. No two plants of equal capacity cost the same as the plants handle different raw materials with different sintering characteristics. Every sintering plant is built to handle definite raw materials which are available to the company that builds the plant, but all plants, regardless of who builds them, or where they are built, should incorporate the two fundamentals, i.e., simplicity and ruggedness, both of which are essential for economical operation. Regardless of initial cost, if simplicity and ruggedness are incorporated in the design, many operating difficulties will be eliminated and a successful operation is bound to follow.

Cost of Operation

The cost of operation varies considerably and also depends largely on the design and location. Many plants are built in locations that are not suited for economical operation, and have complicated flow sheets, which cause numerous delays and high maintenance cost. Many other plants have been built in favorable locations with simple flow sheets and rugged machinery that have been a success for years. The cost of sinter to the blast furnace must be comparable to ore so care should be taken that a modern plant is designed to operate with a minimum number of men and a minimum amount of delay.

The cost above materials depends on what items are included by the accounting department of the company that builds the plant, but all plants have comparable items which are: ignition, fuel, operating labor, repairs and maintenance, supplies, power, water, steam, air, transportation and engineering. Some plants now in operation are producing sinter for a cost so low that it would be questioned by some members of this Association if it was revealed. Many operating men have set a cost above material figure for sinter of $1.00 a ton, but half this figure is high for some plants that are operating at the present time. Future installations should be better operating units than the ones built in the past.

Most of this paper concerns sintering plants that are connected with blast furnace operations, as many of these plants have not shown satisfactory results. Practically all the development and progress in sintering that has been made in recent years has come from operations not connected with blast furnace plants where sinter is the pay-off product, and economical operation is the difference between profit and loss. When more furnace operations are dependent on sintering plants, greater advances in sintering will be made.

Operation of a Modern Sintering Plant

The operation of a sintering plant is not different from any other operating unit of a large company, therefore care should be taken in selecting the proper type of men to run the plant. We all know the working conditions, due to dust, have been terrible in the past, but great strides have been made to eliminate this evil so more emphasis should be placed on personnel to insure a successful operation. There are many cases where a large sum of money was invested in a sintering plant and then the plant put in charge of a man without previous sintering experience. The management never gave him an opportunity to even see a successful plant in operation, so the result was that many operating difficulties were encountered; a poor product was produced and the cost above material exorbitant. After a short operating period the plant was either shut down or costly repairs had to be made to put the plant back in working condition. As the man in charge was not the type to analyze the causes of the operating diffi-

culties or able to consult with the engineering and maintenance departments the plant received very little attention or consideration.

In the last few years sintering has advanced by rapid strides and many favorable reports are available on the advantages of sinter in blast furnace practice, so the old saying "any one can run a sinter plant" is a thing of the past. The man placed in charge of a modern sintering plant should have the ability to take complete charge and be held responsible for the entire operation.

A sintering plant properly designed to sinter definite raw materials, supervised by a competent operator, will produce a satisfactory product at a low cost.

DISCUSSION

J. C. MURRAY, Assistant General Superintendent, Jones and Laughlin Steel Corporation, Pittsburgh, Pennsylvania

M. F. MORGAN, Blast Furnace Department, Republic Steel Corporation, Cleveland, Ohio

G. W. HEWITT, Production Manager, Blast Furnace and Coke Plant, Wheeling Steel Corporation, Wheeling, West Virginia

K. G. LeVISEUR, Superintendent, Blast Furnaces, Replublic Steel Corporation, Youngstown, Ohio

H. A. BYRNS, General Superintendent, Central Furnaces and Docks, American Steel and Wire Company, Cleveland, Ohio

E. W. SHALLOCK, Chief Engineer, American Ore Reclamation Company, Chicago, Illinois

GUY WEHR, Superintendent, Blast Furnaces, Wheeling Steel Corporation, Steubenville, Ohio

C. P. BETZ, Assistant Manager, Blast Furnace Division, Great Lakes Steel Corporation, Ecorse, Michigan

W. T. BROWN, Research Engineer, Jones and Laughlin Steel Corporation, Pittsburgh, Pennsylvania

R. A. LINDGREN, Superintendent of Blast Furnaces, Wisconsin Steel Works, International Harvester Company, Chicago, Illinois

T. W. PLANTE, Assistant Blast Furnace Superintendent, Jones and Laughlin Steel Corporation, Pittsburgh, Pennsylvania

C. M. MYERS, Electrical Engineer, Youngstown Sheet and Tube Company, Youngstown, Ohio

F. F. FOSS, Director of Research and Metallurgy, Wheeling Steel Corporation, Wheeling, West Virginia.

J. C. MURRAY: Most of the fine ores in our Mesaba Range mines are very high in silica. If we have a mixture of flue dust and fine ores, averaging around 13 per cent silica, can we make a sinter without the fused silica structure?

M. F. MORGAN: There have been a lot of theories about fayalite in sinter. I have investigated thoroughly a great many of these and found the idea of fayalite is undoubtedly sintering operation. In other words, if you have a material that is easily fused, and sinter it with excess carbon in the mixture, you will make a sinter with heavy side walls and large pores which are of a glazed nature.

Let me make a statement. A modern sintering plant, designed properly, should be able to give the blast furnace superintendent the kind of sinter he wants. He knows what works best in the furnaces and it is up to the sintering plant operator to give it to him.

Good sinter depends on carbon control. We have plants that run on ore and they have been down as low as 3.77 per carbon in the mixture at the machine. This was ample carbon to make good sinter. Other plants, due to their materials, use much higher percentages of carbon. Every one of your materials have a direct effect on the physical and chemical character of your sinter.

MEMBER: Mr. Morgan mentioned one important item in handling sludge. I wonder if he would elaborate a little on that point and tell us perhaps the best method of handling sludge.

M. F. MORGAN: Sludge is just a terrible product to handle, as all you men know. Some people mentioned putting it out on the stock pile and letting it weather. If you do this, and leave is there 20 years, when you attempt to use it it will be practically in the same condition as when you put it in there, which is nothing but a gummy mass. I have never known a feeder or anything else to give you feed regulation in a plant on sludge that has been stocked. The way we handle sludge, is with a thickener and filter, and take care of sludge that is produced from day to day by filtering and adding it to our sintering plant mixture in the smallest quantities possible and still maintain the same percentage of solids in the thickener overflow.

When we are on 100 per cent operation with four furnaces operating, naturally we have to use more sludge in the mixture than we would if the furnaces were on a low operation. Therefore, in putting sludge into your plant, my advice is to put it in as small doses as you possibly can, because it is not going to be an asset to your sinter or to your sintering operation.

MEMBER: Do you think it is feasible to mix it with fine ore before it is charged?

M. F. MORGAN: It all depends on the moisture in your fine ore. If you have 30 per cent moisture in your sludge, that is 95 per cent minus $\frac{3}{8}$ mesh and you are trying to draw air through a material of this description, you have a sintering problem right away, because you must have porosity in order to make any material sinter. If you add large quantities of sludge that has 30 per cent moisture, and your natural moisture in the sintering mixture is about 7 per cent, you can see the maximum quantity you can add, and still maintain 7 per cent moisture in your sintering mixture, is limited.

We have other plants that are using sludge with success. We take the dry dust and dump it in the ore yard

and then make a mixing pit in this hot dry dust and dump the sludge into this pit. Two buckets of dry dust to one bucket of sludge and mix thoroughly and then drop it down over the dry flue dust pile. All the unmixed sludge rolls down into the bottom of the pile and is returned with the dry dust to the mixing pit and mixed until the dry dust and the sludge contain a moisture you can handle in the sintering plant. Sludge can be handled in this manner, but I think if you handle it in the sintering plant as produced, it is the most economical and the best way.

G. W. HEWITT: I would like to ask about the screening of ore. What size do you recommend for the screening of ore?

M. F. MORGAN: Some plants screen through ½ in. or ⅜ in. and some screen through a ¼ of an inch. I think that depends entirely on the nature and screen analysis of your ore. The precentage of the total screen analysis between a ¼ in. and ⅜ in. of the ores you are going to use may run between 2 and 3 per cent. I know that the product between a ¼ in. and ⅜ in. or between a ½ in. is going to be beneficial to your sintering operation, and it certainly will not effect the furnace practice and may prevent you from having a screen problem.

We are screening to ⅜ in. or ½ in., depending upon the character of the ore we are screening. In doing that, we do it with our sintering plant operating force. In other words, the ore is delivered to the sintering plant in exactly the same condition it is unloaded from the boats and stocked in the ore yard. We screen and discharge the over-size in to a pit.

With a plastic ore, we may have to go to a little larger screen opening, and maybe the screening will not be 100 per cent efficient, but it can be made 100 per cent efficient if the money is spent to put in enough screen area to screen the ore. Therefore, it depends entirely on what is the cost and what can be spent to screen your ore and still have an economical operation. But I say that you don't need anything over ¼ of an in. in screened ore to make good sinter.

G. W. HEWITT: You must have a figure you aim at for the division of your heads and tails on the ore. About what is that figure, 50 per cent?

M. F. MORGAN: We are screening—let me make a specific statement—Beaver ore (and you know the characteristics of that ore) over a ⅜ screen and getting 70 per cent minus ⅜.

G.W. HEWITT: One more question. We have heard it proposed that we cut out the expenses of screening and put the whole body of ore in and sinter it. What do you think of that?

M. E. MORGAN: I would hate to try it. I have tried to use ¾ in. coke breeze in the sintering plant, too. The same thing applies there. In other words, when you have a sintering mixture of all large particles, what have you got to bind them together except carbon?

The air is goung to go through your larger particles with less resistance than through a denser mass, so you have to add more fuel to your material in order to melt the large particles together and this will slow up your

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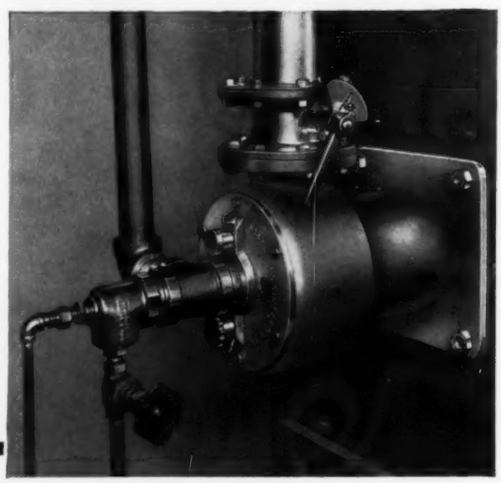

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operation and give you a very dense, highly fused sinter.

A certain per cent of coarse material will give you desired porosity in your bed so you have a uniform cell structure in your sinter, but when you go beyond that you are going right back into what I would say is a lump material again.

Now the point that I make is that every one of your ores has a definite sintering characteristic, and a mixture of your ores might give you an ideal sintering material. If you take out one of these ores or change the percentages, you immediately change your sintering operation as a result. You see, all changes in materials change the characteristics of the sinter.

K. G. LEVISEUR: Will you tell us how much difference in tonnage you get between a poor operator and a good operator?

M. F. MORGAN: I don't think there is so much difference in tonnage as there is in quality, but I will guarantee that the cheapest thing you can have at a sintering plant is a supervisor who will take complete charge, and knows what he is doing and how to run a plant to give you maximum tonnage every day. The cheapest insurance for a sintering plant operation is a man of high enough caliber to be able to communicate and talk intelligently with his furnace superintendent and chief engineer on any problem that arises that might be beneficial to the operation.

When a plant is designed to be put in a location to handle specific materials, the first thing that is said by the management is, "We have an opportunity to buy certain materials cheap. Can you put them through the sintering plant?" No consideration is given as to what the sintering characteristics are, and as a result, usually the furnace superintendent says, "Go ahead and put it through the sintering plant." And what does he get? I am talking now about some fine materials that we have had experience with.

All of those things effect your operation. You don't put anything in a blast furnace that you know will be detrimental to the furnace, but you put a lot of things in the sintering plant that are detrimental to your operation. The man in charge of that plant should be able to give you a detailed report concerning the materials you are asking him to use and be able to hold his tonnage up to a certain standard or give the reason for not doing it. It is the same thing with direct flue dust. If you have a high-carbon flue dust, you have to burn out the excess carbon over and above sintering carbon, and it is going to take time. As a result, you cannot expect a man on straight flue dust to give you the same tonnage as if you give him a mixture where it is up to him to make the tonnage. The tonnage of a plant is governed by the kind of materials you are sintering.

J. C. MURRAY: What is the difference in practice on your furnaces with and without your good sinter?

M. F. MORGAN: The duration of test No. 1 was 31 days, with a coke of 10 per cent ash and one per cent sulphur, wind blown 35,000 cu ft on a 17 ft furnace; two furnaces of the same diameter, 35 per cent sintering one one and no sintering on the other. We showed an increase on the furnace with 35 per cent sinter of 1679 tons

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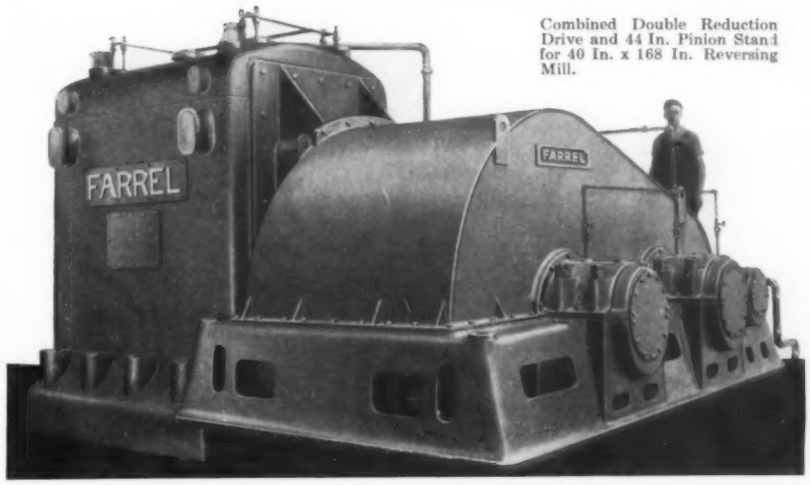

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of pig iron and reduction of coke practice of 192 lb of coke per ton. Furnace A, which had the sinter, made 42 lb less flue dust than Furnace B, which was rather disappointing. Flue dust figure in each test represents total dust, dry dust plus gas washer dust. With 35 per cent sinter, you can practically say 200 lb coke.

J. C. MURRAY: What was the increase in production?

M. F. MORGAN: It was 1679 gross ton in 31 days.

J. C. MURRAY: That is about 10 per cent.

M. F. MORGAN: Yes.

H. A. BYRNS: Is it practical to take filter cake direct from the filter to the sinter plant bins, or should it be put on the ground first and allowed to set awhile? Can it be handled in the bins direct from the filter?

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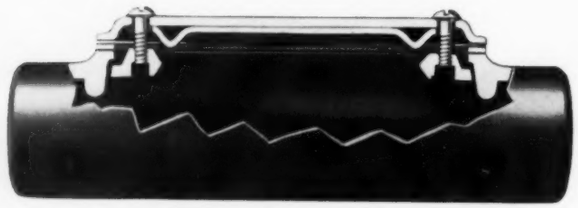

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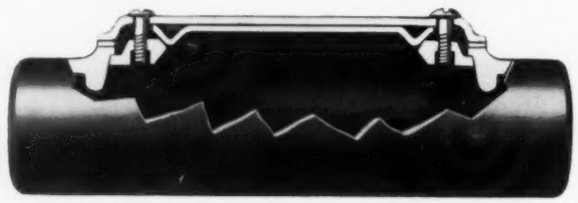

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M. F. MORGAN: I have never seen a feeder yet that would handle sludge.

E.W. SHALLOCK: I agree with Mr. Morgan. In all my experience, I have never seen a feeder that successfully handled sludge. Any feeder can be made to feed, but you cannot depend on it giving you any degree of regularity, and it needs almost constant attendance to make it feed. So I would say that I don't know of any suitable feeder for sludge.

GUY WEHR: Would it be possible to store the sludge from a thickener and pump it to your pugmills the first thing every morning when you pug your dust, and have a pretty good disposition of it, or temper your dust to about the degree you want it?

M. F. MORGAN: If you figure on a fifty-fifty basis, I don't see any reason why you can't. The only thing about your sludge is, as I said before, 95 per cent of it is minus $\frac{3}{8}$ in. mesh. The percentage of it that you put in the sintering mixture is going to reduce your sintering tonnage by the amount of time it takes for your air to travel through your charge.

I figure if you are going to make 20 tons a day of sludge on your furnaces, that 20 tons ought to be spread over a 24-hr period. If you take your flue dust, dump it in the morning, and accumulate the sludge for 24 hrs, you might have a very good mixture when you are making high dusts on your furnace, but when you get down on a good dust figure, maybe your sludge will turn your dry flue dust into sludge. Another thing you have is a whirler dust, and there is no merit in whirler dust in a sintering plant. Therefore, the fines of the dust depend a lot on what your tonnage would be.

C. P. BETZ: Has any consideration been given to the installation of a small rotary dryer through which the filter cake could be passed?

M. F. MORGAN: My experience has been that in all drying, the sludge will roll up into balls. When it rolls into balls, then it will go into a hard lump, and these lumps, will probably be an inch in diameter and under. All of those lumps are going to roll directly to your grate bars, and in rolling to the grate bars they contain absolutely no carbon but, due to the heat, they will break up and cause dust and contamination of the sinter as it goes into the pile. If you can dry your sludge and then crush it, bring it back into your whirler dust

state, you still have minus 3/8 mesh material you are trying to use.

Now, the whole theory that I have on sludge is to handle it in as small quantities as you possibly can. Get a thickener that is big enough to take care of an excess amount, and then when you get into a jam you can cut your sludge off and get back on your feet again. Now when you talk about a dryer and so forth, you are going into a whole lot of money. I believe that putting the sludge in the sintering plant in as small quantities as possible, is the most economical way to handle it.

C. P. BETZ: I shouldn't think that 20 to 30 tons of filter cake in 24 hrs. would be an excessive amount to handle, and would not require a very large dryer.

M. F. MORGAN: The only thing is the cost of it. If you don't have to dry it, there is no use in drying it.

C. P. BETZ: In order to make a uniformly good grade of sinter it is necessary that the filter cake be mixed uniformly in the raw material going to the sinter machine, and I believe that the partial drying of filter cake would make this possible.

M. F. MORGAN: We have two 70-ft thickeners in Cleveland, and we put these thickeners in to handle the sludge from four small blast furnaces. We now have two small and two 25-ft furnaces. Our thickener is still handling it. We have increased the tonnage of the sintering plant from 400 or 500 up to 1000 tons. So the percentage of sludge I am getting in my mixture today is practically the same as I got when I had the small sintering plant. We are running that filter cake in our plant continuously. When we have a 24-hr delay, we don't think anything about it, because the thickeners are big enough to handle the excess sludge accumulated. We regulate our filter cake according to the sintering operation, so we can handle it all and still get by with it.

I have been around to quite a few plants, and, as I say, we have tried to handle sludge the same way as they aniline sludge in the East. I have seen piles of that when dried. It is either in a hard massy form or a gummy substance. If you get it thoroughly dry, you just can't handle it, because it will blow out as powder.

All these fine materials must be handled the simplest way, and not contaminate your sinter. In other words, if you are mixing 1000 tons a day and you put in 80 tons of sludge over a 24-hr period, your amounts are not so large that it is going to affect your sinter.

W. T. BROWN: What is the specification for good sinter: screen size, or physical or chemical tests that can be applied?

M. F. MORGAN: As I said before—and I also said it one time down in Pittsburgh—the only standard you have to go by is the blast furnace superintendent. That is the only thing I can say. I have worked for a good many of them in my time, and they all have their own ideas of what is good and what is bad sinter. Therefore, if you are working for a definite blast furnace superintendent, you have to give him what he wants.

W. T. BROWN: It is in just the same category as blast furnace coke. The blast furnace superintendent does not know what is good sinter, but he knows how it works in his blast furnace.

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M. F. MORGAN: Absolutely. They are both auxiliaries to the blast furnace, whether you are running a coke plant or a sintering plant, and what he says he wants, you try to give to him.

W. T. BROWN: Do you have any tests that can be applied?

M. F. MORGAN: Not that I know of.

W. T. BROWN: Could there be any tests developed?

M. F. MORGAN: We all have our own ideas, the same as you have on coke, but I would hate to expound my ideas because they would not conform with the ideas expressed in former papers.

I could give you some of the ideas I have had from furnace superintendents. One was, when I first started, if you held a piece of sinter up, of any size, and dropped it and it broke, it was no good. Therefore, what did I have to do? I piled excess carbon into the mixture so when he picked a piece of sinter up and dropped it, it did not break.

J. C. MURRAY: I would like to answer Mr. Brown's question. A number of years ago, we purchased, from the Witherby-Sherman Company, some 15,000 tons of sinter; Old Bed, I think they called it. This sinter contained lumps as big as your head but if one of these lumps were dropped it would fracture into innumerable pieces, showing that it was very friable, probably caused by sintering at a low temperature. When entering the skip bucket it seemed to contain too great a quantity of small material and we were afraid it would not show up well in the blast furnace but our results were excellent, which proves a hard burnt, strong sinter is not what is needed. About the same time we made a test on the Aliquippa sinter, which was something like your Cleveland sinter, and the blast furnace results were rather disappointing.

M. F. MORGAN: That is a matter of carbon content and the characteristics of the ores used to make the sinter.

You are talking about a material made of fine magnetic concentrates, all minus 10 mesh. The only fuel used was anthracite coal. That man has absolute control of his mixture at all times because he only has two ingredients going into the plant, concentrates and hard coal. When you talk about a sintering plant at a furnace, it is getting flue dust. There may be four furnaces or six furnaces, and the flue dust from each furnace has different characteristics. There are not any two furnace dusts alike. One may be very good, and another very undesirable. It is caused by the difference in the grade of iron-made: silvery iron, basic iron foundry iron, malleable iron. You put a certain amount of flue dust in your mixture, and then you have your lake ores, and their moisture content to contend with, as well as the silicates. One ore will run 4 per cent silicon, another one 1½ per cent, and you mix the materials according to the way the blast furnace superintendent wants them. You have to give the best possible product with what you have. If you have ideal conditions in a sintering plant, you should be able to give him ideal sinter. We have found what we like to have is when the material gets to the big belt of the furnace, we do not have any particles plus between an in. or two in size.

W. T. BROWN: What about uniformity?

M. F. MORGAN: Uniformity of product is very important. A lot of men are crushing their sinter and sizing it, but we find that you can do a pretty good job by the time it is dropped to a pit and picked up by the ore bridge bucket and dropped into the transfer car and from the transfer car to the bin, to the scale car, to the skip, and from the skip to the small bell, to the big bell, it gets a pretty good workout and will be pretty uniform in size.

R. A. LINDGREN: I wonder if Mr. Morgan would care to tell the group

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something of ignition furnace design and its effect on speed of operation of the plant. I believe he has some definite ideas on that subject.

M. F. MORGAN: There have been a lot of things that have come up about ignition. In the past we have had, and it has been universal, an ignition furnace with a spread about 12 in. on the bed. Ignition is what makes your sinter, because you must light it before it will burn. Therefore, if you speed your machine up, you must force this burner beyond its capacity, in order to get good ignition.

If you have a little variation in moisture, your flame is not on your product long enough to ignite it. Therefore, it is raw material going off the end of the machine.

I know you will be interested in a theory we are working on. We are developing an ignition furnace that is about 83 in. long, so that if you run the sintering machine at 83 in. per minute, you will have one minute ignition time. This means you will be able to carry a much lower temperature in the burner, thus reducing the high maintenance cost, and be sure you have thorough ignition over the complete surface of the bed.

I honestly feel that we have been jeopardizing the tonnage on a sintering plant by babying the ignition. Maybe we are not carrying enough moisture in our feed. I think that the longer ignition furnace is going to be a big step in the way of helping to increase production.

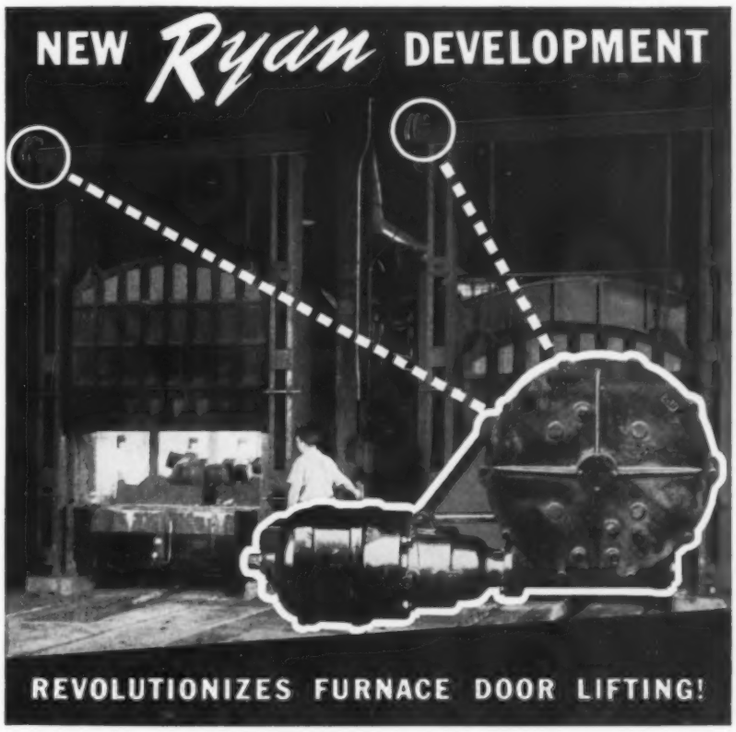
I did see a furnace in one of the plants in this country that was 18 ft long, and that machine was running at 165 in. a minute. Gentlemen, that is the fastest thing I have ever seen in sintering. The machine is 102 ft long, and they are using it on phosphoric matrix, and you could just imagine what their tonnage has gone up to by being able to keep that material lit at that speed.

The average speed at which you run a big machine is around 75in. to 80 in. a minute, and I believe these speeds have been governed by ignition.

On the batch process, we go from cold to hot, and we have found that ignition is accomplished in about 40 sec to a min and 20 sec. If we can hold a temperature on our machine that will give us favorable sintering time or ignition time, I feel that we are going to show a big improvement in the operation.

T.W. PLANTE: Would you consider subdividing the wind box into several compartments?

M. F. MORGAN: No. I will give you my reason for it. You do not have uniform suctions along your sinter bed due to the condition of the materials. When you charge the materials on the sintering machine you try to have them in a loose, fluffy condition. If you have too much suction on this raw charge it will pack and the air will not pass through it properly. After the charge is ignited you depend entirely on the suction to continue the sintering action. The farther your charge travels toward the discharging point the more tendency your charge has to dry out, and naturally the sintering action must be more rapid. This is accomplished by a large volume fan drawing air all along the machine with unequal amounts coming from each wind box section; the greatest from the last wind box and the least from the first wind box. You have a certain amount of fuel to burn out of a sintering charge and you must have enough air to accomplish this, but an excess of



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air will not increase your tonnage or improve your operation. Usually excess air demands excess carbon in the charge, which causes large pore, glassy sinter. You can over-blow a sintering charge the same as you can a blast furnace, and also under-blow it. The materials you are sintering govern the amount of air you need and this amount of air can only be determined by actual operation. Uneven distribution of air, applied mechanically, has never insured increased production to my knowledge.

E. W. SHALLOCK: I would like to say something in explanation of what Mr. Morgan said about ignition time. He mentioned a plant for sintering phosphate materials. That material has about 30 to 35 per cent moisture at times.

There, too, they started out with a furnace that was short in length and had a short ignition time, but they still made good sinter. The reason they went to the longer furnace was that their moisture content had gone up. They were crushing their material finer, and because of the high moisture content and also because they changed from oil to coke oven gas, it was necessary to design a different type of furnace, and that furnace is about 6½ ft or 7 ft long.

The length of time required to get ignition depends entirely on the material. Now, at the Evergreen Mining Company in Minnesota, they have a long ignition furnace, because that ore, too, at times has as high as 30 per cent moisture, and it is difficult to ignite it because of the high moisture content.

There are other plants that have drier materials that do their igniting in 10 to 15 sec and I think that when you talk about long ignition time, you must consider the character of material that you wish to ignite.

M. F. MORGAN: The only point I wish to bring out about the long ignition furnaces is that I know the Evergreen Mining Company plant, and I think they are doing about as fine a job on the plant as they can. If they have 20 per cent moisture, maybe we are barking up the wrong tree in holding 7 per cent moisture and trying to light it within 10 to 11 sec. Maybe we are wrong.

So if we can go up in moisture and get more tonnage, why shouldn't we take advantage of that?

C. M. MYERS: My question is just a little diversion. What prompts the choice of the motor for your fan? Some use a synchronous motor. Others are using induction motors. What prompts that choice?

M. F. MORGAN: I should say the electrical department of the plant where the sintering plant is going to be built. In fact, I have found, as an operating man, that the more you stay out and let the electrical engineer have what he wants in the sintering plant, the less trouble you are going to have with the electrical end of it.

C. M. MYERS: In other words, it doesn't hamper the operation of the job whether it runs constant or varies somewhat.

M. F. MORGAN: Not a bit.

F. F. FOSS: Mr. Morgan's paper on design and operation of a modern sintering plant covers, rather thoroughly, the first half of the title, that is, "design." However, he didn't dwell long enough on the other important part of his assignment, that is, operation of the sintering plant and actual "making of sinter."

In the discussion, Mr. Morgan ridiculed the old adage that "anybody can run a sintering plant." This remark was quite appropriate as, up to the present time, with all developments taking place in sintering, not enough attention is paid to the most important part of this progress, that is, metallurgy of sintering.

The importance of sintering, in general, and, particularly, of fine iron ores and flue dust, is now fully recognized by everybody in the iron industry and, just recently, E. W. Shallock, in his paper on sintering of iron ore, published in the August, 1941 issue of THE IRON AND STEEL ENGINEER, summed up the importance of iron ore sinter in the following words. "Good, strong, porous sinter is more desirable than the best ore in this country because it makes possible a greater production of pig iron, because it lowers fuel consumption, because it distributes itself better in the furnace, because it provides a more intimate and greatly increased gas contact, because it decreases flue dust production, because it prevents channeling and slips, and because it greatly improves quality and uniformity of pig iron."

We even hear that the idea of sintering of all ore going into the blast furnace is very close to realization in one of the nation's plants.

In each metallurgical installation, there are always two main parts present. One is based on the principles of mechanics and the other on the principles of physics and chemistry. Mr. Morgan showed the degree to which development of the mechanical side has brought the art of sinter making and it seems to me that the other side of the picture has not been emphasized enough. The plan and design of a sintering plant is, of course, a very important part of the whole lay-out. Transportation and flow of raw material should be logically arranged and mechanical equipment and machinery should be of the highest efficiency and made from suitable materials. The scientific principles underlying treatment of different raw materials to get highest quality sinter, however, are of as great importance as the former, if not greater, if an efficient utilization of raw materials is expected.

The theory of the sintering process has been developed in Europe and brought to high perfection during the last two decades. Several profound studies of the sintering process were conducted in England, Germany, Russia and France. During the same period, many papers on flue dust and ore sintering, covering the subject rather extensively, have been presented in this country as well. Some of these papers, as that on "Iron Ore Sinter," by G. M. Schwartz and "The Sintering Process and Some Recent Developments," by J. E. Greenawalt, carry all marks of classical studies.

With all this in our hands, there is still not enough realization among operating people that, by application of principles of metallurgy to the sintering process, the operator can make his product answer the most strict demands of the blast furnace man.

Mr. Morgan mentions that the "first thing that governs the design of a modern plant is a thorough knowledge of all materials that are available or can be made available for the sintering operation," and there is a lot to that statement.

If all characteristics of the materials were known to the operator of the sinter plant, the blast furnace man could get a sinter of only one high quality, provided, of course, that, in making of sinter, all knowledge of metallurgical principles is applied. I think it is appropriate to mention that the best results in preparation and utilization of sinter can be ex-

pected in a case when the sintering plant is run by the blast furnace operator. The blast furnace man, who, by the nature of his profession, is solving, every day, problems connected with oxidation of metals and reduction of oxides, should always know what kind of product he needs and at what time. He knows, every moment, what his furnace demands, how it runs, how gases in his furnace will penetrate the sinter and what size of sinter he needs for every phase of his production. Then, he, as an operator of the sinter plant, will soon recognize that sintering is a very delicate operation, demanding good knowledge and understanding of oxidation, reduction and fusion phenomena taking place in sintering. He will see that, although sintering, in general, is preeminently an oxidation process, it has, also, reduction phases. Reducibility and fusibility of the sinter will depend on intensity of his blast in the sintering machine,temperature of sintering, cooling of the sinter after operation, and many other factors which he will find out by constant chemical analyses of materials entering into production and micro-petrographic studies of the finished product.

The necessity of preparation and proper classification of raw materials going into sintering is well known and cannot be over-emphasized. The science of raw material classification has made such strides that nearly every phase of these processes can be expressed mathematically. Dependence of gas flow from the height of material layer and size of the particle is expressed, nowadays, by the empirical formulae developed by several investigators, preeminently Ramsin, Bansen, Baake, Luyken and others. The first-two-named investigators developed their formulae for air draft coming "up" in the layer. The others studied air penetration "down" the thickness of material by suction.

By regulation of the amount of air and temperature, a certain type of oxidation of iron ore can be achieved and the most desirable, from the point of view of reducibility, iron oxides, can be obtained. It is interesting to note that the "martite" form of hematite (crystallized in octahedrons, pseudomorphous after magnetite) has been found in the properly heated briquettes.

The type of oxide in which flue dust or ore is oxidized during sintering influences the good or bad humor of the blast furnace operator. It is quite clear that, if the sinter is too silicious, the sintering must be conducted at lower temperature and with fluxes to minimize the occurrence of fayalite.

The purpose of these remarks isn't to present details of sintering metallurgy but only to emphasize that, if a sintering operator wants to get results, he must conduct continuous study of his process and products along the lines so well drawn by Messrs. Schwartz, Greenawalt, and Joseph (in his Iron Blast Furnace Reactions), as well as other investigators of the same caliber.

When application of metallurgical principles to sintering is made to the fullest extent, it will be found that use of sludge in sintering process of fine ore and flue dust is far from advisable. Study of gas and heat penetration through the mass of very fine material (above 200 mesh) will again show that utilization of sludge should go in the other direction, namely, making from sludge and crushed ore small-size thin briquettes and heating them at low temperature for a relatively long time. In this form, the sludge will produce desirable material to be used in the blast furnace rather efficiently.

When metallurgical (physico-chemical) principles will be applied to the making of sinter to the same extent as application of mechanical principles described by Mr. Morgan, the art of sintering will give a much more satisfactory product than at present.

JOINT MEETING

Pittsburgh-Cleveland Section

WARREN, OHIO - JUNE 1, 1942

2 P. M. INSPECTION TRIP
6 P. M. DINNER
8 P. M. TECHNICAL SESSION

ASSOCIATION OF IRON AND STEEL ENGINEERS

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Sizes No. 10 to 18 A.W.G. with two or three conductors insulated with felted asbestos, covered with asbestos braid. Also in A.V.C. (asbestos and varnished cambric) constructions.

This heat-resisting flexible cord is ideal for high-wattage lighting units, floodlights, blueprint machines, apparatus, etc., which require a heavy duty, enduring cord. For moisture-resistant construction specify the A. V. C. type. Labeled cord with polarized conductors if desired.

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(Underwriters' Type AVA)

Sizes No. 18 to 4/0 A. W. G. This construction for sizes 18 to 8, sizes 6 to 4/0 have another wall of felted asbestos next to the conductor.

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A multi-conductor control wire for low voltage intercommunicating, signal and temperature control systems. Its lifetime insulation and rugged steel armor will give you troubleproof circuits.

600 VOLT ALL-ASBESTOS RHEOSTAT CABLE—TABLE R

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Sizes No. 18 A. W. G. to 1,000,000 CM insulated with a heavy wall of felted asbestos, covered with a rugged asbestos braid finished in black, white or colors.

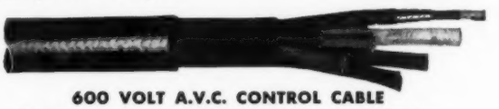
Use this power and rheostat cable for wiring rheostats, switchboards, elevator and locomotive control panels and electrical equipment exposed to heat, fumes and fire hazard. Also for general open wiring in dry, high temperature locations. For solid conductor specify Rockbestos Rheostat Wire, Table A.

600 VOLT A.V.C. MOTOR LEAD CABLE—TABLE L

(Underwriters' Type AVA)

Sizes No. 18 A. W. G. to 1,000,000 CM insulated with two walls of felted asbestos and a high-dielectric, heat-sealed varnished cambric insert, covered with heavy asbestos braid.

Heatproof, fireproof, greaseproof and oilproof, this cable will not dry out and crack, won't burn or carry flame, and will remain permanently flexible. For coil connections, motor and transformer leads where extreme heat and fire hazards are encountered as in steel mills, boiler rooms, etc.



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Designed for use under conditions too severe for control cables with other types of insulation which deteriorate rapidly when exposed to high temperatures. Operates without failure under the attack of heat, oil, grease or corrosive fumes and may be installed in conduit as it has ample moisture resistance.

600 VOLT A.V.C. POWER CABLE—TABLE E

(Underwriters' Type AVA)

Sizes No. 18 A. W. G. to 1,000,000 CM insulated with laminated felted asbestos and varnished cambric, and asbestos braid. Other constructions for service voltages up to 8000.

This cable is recommended for power circuits and hot spot wiring in or around boiler rooms, ash pits, steam tunnels, soaking pits, tenter frames, glass plants, steel mills, etc. The asbestos and heat-sealed varnished cambric construction has ample moisture resistance and withstands high temperatures indefinitely.

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MAINTENANCE of INSTRUMENTS and CONTROLS in the Steel Plant

By R. A. Weikel, Supervisor of Instruments

BROWN INSTRUMENT COMPANY

Pittsburgh, Penna.

Presented before A. I. S. E. SPRING CONFERENCE
YOUNGSTOWN, OHIO

▲ THE last 200 years have seen a rapid growth of science and scientific achievement. This meant that new tools increasingly became available and when man began to appreciate their use, big strides were made in the advancement of the science of production. Increased production, which means more output and less rejects, has been brought about by a combination of many factors, not the least important of which has been the increasing use of instruments which first, measured and later controlled industrial processes.

As processes became more exacting, instruments developed from the simple indicating gauge to controllers which maintain complete systems. At the same time men developed to govern this rapidly growing instrument demand and to set up rules and regulations for specifying, operating and maintaining the instruments and controls.

When considering the instrumentation of a plant, it is advisable to consider first, the men who are responsible in any connection for the instruments.

Trained instrument men should form a separate instrument group. They should be responsible to the fuel, the maintenance or the steam department. They should specify the instrumentation for new developments, install, check, calibrate, repair and maintain all instruments and control devices. They should have charge of the complete instrumentation of the plant.

There is an advantage in making the instrument group responsible to a service department such as the maintenance department, rather than to an operating department, in that they can cooperate with all departments to the same degree. It is not satisfactory, for example, to have the pyrometers supervised by the electrical department, while at the same time the fuel department is responsible for the flow meters and the pipe fitters take care of all pneumatic controllers because of the valves and piping. Although the plant electricians service electrical contact devices which are as complicated as any measuring instrument or control devise, the overall problem is different. A full knowledge of the measuring ability of the various instruments and of their mechanical and electrical limitations will enable a separate instrument group to function with rapidity and efficiency. Also, no division of responsibility occurs, nor is there any duplication in ordering spare parts or supplies, which may be common to several instruments.

This paper should perhaps have been titled "Maintenance of Men and Instruments and Controls in the Steel Plant," because of the importance of each factor in relation to the others. Instrument men should not be considered as glorified or graduated pipe fitters or electricians. They are specialists and should be so considered. They should be specifically trained to appreciate the problems involved in the maintenance and use of instruments and controls. It is true that pipe fitting and electrical skill are essential in the application of the instrument and the control, however, the complete problem includes a knowledge of theory as well as practice. Because of this, it has been demonstrated that the type of men generally found most suitable for this work are those who have had at least two years of technical education in some engineering school, or its equivalent in practical experience. These men have, generally, by training and inclination, acquired a certain amount of skill in handling tools and equipment and have become "practical mechanics." With some additional specific instrument training given either by the plant instrument department or by an instrument company, these men become well qualified to form the personnel of the instrument department.

Instrument training given by the plant instrument department is more specific and in most cases deals more with the application of instruments to the particular industry or to the type of instruments used in that industry. A training course given by an instrument company would be more general and would include, to a greater degree, the theory and adjustments of the instruments themselves. This type of training would, in addition, familiarize the man with instruments which may not, at the moment, be applicable to the particular plant, but which might be very valuable in future developments. There is an advantage, also, in temporarily

divorcing the trainee from all responsibility for plant maintenance so that he can concentrate his thoughts and efforts on the study of instruments. A combination of both types of training will produce the best men.

The time necessary to train a man will vary, depending on his previous knowledge and experience, and the qualifications necessary for the work he is to undertake. Some men are exceptional and even without training will be able to assume a responsible job in the instrument department in a short time. The average man without training, however, may take a year to be of real value. This time can be shortened materially with proper training and any time allotted to training is usually well repaid. A rotation of duties will also be found to be beneficial to the department as well as to the man. One of the thoughts which should be stressed when training instrument men is the fact that they must work in close conjunction with the operators. Their relations should be harmonious. This enables the instrument man to broaden his education and get a better understanding of the process. The operators will, at the same time, more fully appreciate the problems of the instrument group.

It is not always sufficient that the instrument man alone masters the operation and maintenance of an instrument in order for it to give satisfactory performance. In most cases it is equally important that the proper application be determined by the supervisor of the instrument group.

One of the most important duties of a complete instrument department should be to specify all instruments. This procedure allows the instrument department to use experience obtained in other installations or many other factors which are pertinent to good installations. In some plants type-of-instrument standards have been adopted which specify that for a particular job a pyrometer shall be used; or, on another job, a pneumatic operated controller shall be used, etc. On the other hand, these type-of-instrument standards may be set up according to the major conditions to be considered. Such conditions may be:

1. Dependability.
2. Simplicity.
3. Flexibility or applicability.
4. Accuracy.
5. Readability.
6. Responsiveness.
7. First cost.
8. Maintenance.
9. Life.

This second method of standardization is more flexible because it imposes less restrictions on the man who specifies the instruments. As manufacturing and economic changes occur, products and processes must be changed to suit the new conditions. In this case the man who specifies the instrument is not bound by an obsolete set of rules. He merely decides which condition is the most important at the moment or for the particular job and then picks out the instrument which will meet the conditions and at the same time, do the job. In this respect it is interesting to note the sentiment among instrument maintenance men in favor of replacing electrically operated controllers, in some cases, by pneumatic controllers. If the rules or customs demand an electrically operated valve, perhaps for no other reason than because an electrically operated valve has always been used, advantage cannot be taken of the close control and lower maintenance costs available with a penumatic device.

The instrument group should have its own office and shop where records can be filed and repairs made. This should be a large well lighted room. It should be free from heavy vibrations and shock, clean and with a dustproof ceiling and free from smoky or clouded atmosphere. The latter specification is almost impossible in the average steel plant but, at least, the requirement can be kept in mind. A complete set of all necessary testing equipment should be supplied, which along with the special tools and instrument spare parts, should be stocked in the instrument department.

The instrument supervisor should, after determining the major requirements of an installation such as dependability, simplicity, applicability, etc. then consider the process with the following in mind:

I. Does it require
- 1 — An indicator
  - (a) size
- 2 — A recorder
  - (a) circular chart
  - (b) strip chart
  - (c) single record
  - (d) multiple record
- 3 — A controller
  - (a) electric
  - (b) pneumatic
  - (c) hydraulic
- 4 — An integrator

Next, the following specifications should be developed:

II. 1 — Instrument
- (a) voltage and frequency
- (b) type of clock
  - (1) electric (time interval)
  - (2) handwound (time interval)
- (c) mounting
  - (1) surface
  - (2) flush
- (d) connection
  - (1) bottom
  - (2) back
  - (3) top

2 — Thermometer
- (a) material
  - (1) bulb
  - (2) socket
- (b) distance of union above bulb
- (c) tubing
  - (1) type
  - (2) length
- (d) If vapor tension fill
  - (1) bulb elevation

3 — Pyrometer
- (a) thermocouple
  - (1) type
  - (2) gauge
  - (3) length
  - (4) protection
- (b) extension leads
  - (1) type of insulation
  - (2) length

(c) millivoltmeter
(1) depression rate
(2) safety feature
(d) potentiometer
(1) multiple record
(a) type of mark

4 — Flow Meter
(a) fluid conditions
(1) temperature
(2) pressure
(3) specific gravity
(4) capacity
(b) fluid measured
(c) primary element
(1) thin plate orifice
(2) flow nozzle
(3) venturi tube
(d) transmission
(1) electric
(2) mechanical
(3) pneumatic
(e) pipe
(1) inside diameter
(2) clearances
(f) flanges

5 — Valves
(a) trim
(b) size
(c) body
(d) connections
(e) action
(f) timing
(g) allowable drop
(h) type
(1) quick opening
(2) V-ported

6 — Anything special.

The instrument department should keep complete records. These should be as detailed as is practical and should include:

1. A sketch of the installation.
2. A memorandum of the factors determining the selection of the equipment.
3. A copy of the shop instructions for installation.
4. A copy of the manufacturer's instructions.
5. Date.
6. Cost.
7. Customers and suppliers order numbers.
8. Instrument serial and model numbers.

The foregoing information is the foundation of the life history of each installation and in many cases proves to be invaluable at a later date.

Maintenance records should also be kept. These should include records of the time and material used to keep the installation operating in a satisfactory manner. They should also include any individual peculiarities of the instrument or the job. These records enable the instrument department to calculate the maintenance expense for various makes or types of instruments and enables the instrument supervisor to consider his decision on the selection of the instrument.

The record produced by the instrument itself, which is a record of the process or product should be filed separately so that ready reference can be made by the management for duplication of product. These records should be in the care of a competent chart man. It should be the responsibility of this man to see that a legible record is obtained regardless of what might be entailed. This would include having a supply of charts, having the proper ink, i.e. slow, medium or quick drying and keeping the pens in good working condition.

Instruments should be checked at periodic intervals. How often? That depends on the accuracy required. If an instrument is used merely for duplication, i.e. where the material produced yesterday or last month has proven to be satisfactory and a repetition is desired of the conditions under which it was produced, the exact value of the line on the chart is not critical. In this case the exact calibration of an instrument is not too important, provided it repeats. As long as the mechanical action of the mechanism is free and deterioration of all primary elements is avoided, duplication is assured and satisfactory performance will be obtained over long periods of time without checking. If, however, the exact value of the reading is desired, the instrument and its primary element should be checked frequently. An extreme case of the latter condition is one where an instrument is checked every 8 hour shift.

Checking and calibration are terms sometimes incorrectly used as synonyms. An instrument, an installation or a primary device may be checked or inspected to see if it is calibrated correctly, installed properly or working satisfactorily. If not correct, the degree of error may be such that the error is negligible or the results may be within the limits necessary for satisfactory performance. Calibration, on the other hand, implies checking against a standard and then, if necessary, correcting the instrument to agree with the standard.

Standards may be primary or secondary. Primary standards are those used as bases or absolute values, against which all other values are compared. They should only be used by competent persons who appreciate the care involved in their use. A secondary standard is one that is checked against the primary standard and, in turn, used as a base to calibrate the operating instrument. The secondary standard is generally constructed more ruggedly and designed for portable use.

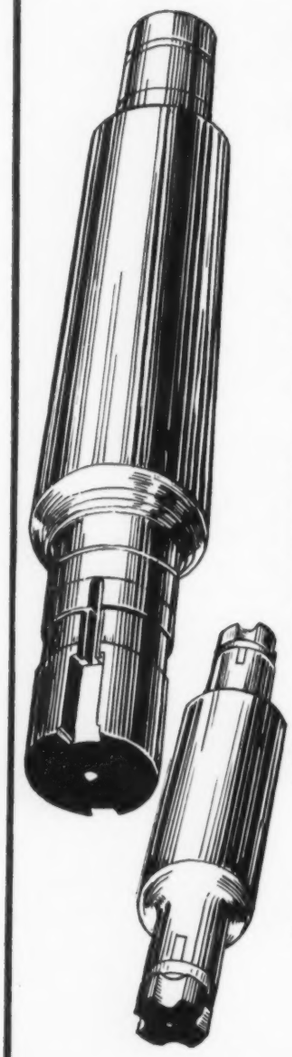
The instrument department should have control of the standards and should carry in their stock the necessary equipment to calibrate the instruments against the standards. This statement should naturally be considered from the standpoint of cost, although accuracy does not always entail the use of expensive equipment. In most cases the type of equipment and the care with which it is used are the most important items to be considered.

To maintain instruments properly, the instrument department must develop their own general and specific tests for checking. It is suggested that these tests be covered by written specifications so that all similar tests be made in a like manner even though made by different individuals.

A careful analysis should be made of the types of instruments and controls in use to determine which ones should be repaired at the plant or which ones should be returned to the instrument company for repairs. This analysis should consider:

1. The type of repair.
2. The time involved.
3. The probable cost.

NATIONAL ROLLS



Precision Before Profit

YOU cannot hurry or trifle with roll production. Too much depends on it, not only in the rolling mills themselves but far on ahead in the multiple services for which shaped metal is used.

We make NATIONAL ROLLS that make steel behave. Their careful chilling, precision of shape, and superior machining and surfacing finish them as desired — as perfect and reliable as rolls can be made, so that we may be proud before we are prosperous.

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President and General Manager

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4. The equipment necessary.
5. The skill required.
6. The men available.

Consideration should also be given to the possibility of making emergency or field repairs.

The foregoing factors, along with the number of instruments and their locations should determine the number of men required to staff the instrument department. If the plant is spread out over a large area; smaller sub-divisions, conveniently located, may be more economical for filing charts and basing men used in that area. In this event, however, it is still recommended that a central office be maintained for records, repairs, stock parts, etc.

Another important consideration of the instrument department should be the location of the primary device and of the instruments. The location of the primary device, whether it be a thermocouple, thermometer bulb or thin plate orifice is of such importance that the major instrument companies have standard printed instructions to cover this point. However, the success of an installation may depend on the interpretation of these instructions by a trained instrument man. The untrained man may not appreciate that the close tolerances allowed are not merely a desire on the part of the instrument company to be fussy but rather, the result of their experience in many installations.

The location of the instrument is important. Accessibility for chart changing, readability, maintenance or repair must be considered. The major instrument companies consider appearance in the manufacture of their product and very little excuse exists for hiding an instrument in an-out-of-the-way corner. Automatic control, for example, has been developed primarily for the purpose of maintaining a cycle or a program at a predetermined value. Naturally, the controller should have a convenient and proper means to adjust its control characteristics. If the controller is properly designed, the instrument man will not object to making adjustments when needed. However, the instrument should be located so that this adjustment is at hand. Experience has shown that in many applications the ease with which adjustments can be made may mean the difference between success and failure of the control instrument. Another important factor to be considered in a control application is the suggestion that a separate instrument be used for each control job.

The value derived from an instrument can also be increased by locating it in such a manner as to be easily and readily used by the operators. Instruments should be mounted on a panel in a neat, well arranged manner, properly lighted, and protected from dirt. Consideration should be given to their height from the floor. If a tall panel is used it might be put in a pit for convenience. Panel houses should be considered. The instrument supervisor should insist on a neat, convenient arrangement of the wires and piping at the rear of the panel with good light and space for working.

In the foregoing discussion we have attempted to show how an instrument department should be set up and to outline some of the duties of this department. Its success will depend on the ingenuity and imagination of the instrument supervisor, who should be given the fullest authority to use the knowledge and experience he has acquired.

DISCUSSION

C. L. McGRANAHAN, Assistant General Superintendent, Jones and Laughlin Steel Corporation, Pittsburgh, Pennsylvania
O. J. LEONE, Sales Engineer, Bristol Company, Pittsburgh, Pennsylvania
L. A. DEESZ, Combustion Engineer, Republic Steel Corporation, Youngstown, Ohio
C. L. DUDLEY, Steam Engineer, Jones and Laughlin Steel Corporation, Aliquippa, Pennsylvania
W. P. HILL, Steam Engineer, Bethlehem Steel Company, Sparrows Point, Maryland
L. F. COFFIN, Superintendent, Mechanical Department, Bethlehem Steel Company, Sparrows Point, Maryland
J. L. MILLER, Assistant Chief Combustion Engineer, Republic Steel Corporation, Cleveland, Ohio
R. A. WEIKEL, Industrial Sales Division, Brown Instrument Company, Pittsburgh, Pennsylvania
R. I. GUMAER, Fuel Engineer, Jones and Laughlin Steel Corporation, Aliquippa, Pennsylvania

C. L. McGRANAHAN: I would like to throw a little challenge out to the instrument salesmen today, and accuse them of overselling a little bit. I am speaking now after having been in the mechanical department for many years, and being in the production department now. One of our big problems at times is to know what to do with charts. We spend a great deal of money putting in automatic control. We pay an exceptionally high rate of wages to the man running this equipment. We provide an instrument bureau to take care of it. Then we put on a recording instrument that day after day gives us a periodically continuous straight line.

Now, there are places where we need charts. There are a good many places where we do not need charts. I am not ready to say now that we do not have a few dependable workmen, and that they do not earn what we pay them. I don't think it is necessary for us to put a recording detective bureau on, to make them earn the dollars and cents that we pay them. The result is that we have miles of charts that we don't know what to do with.

In my own particular instance, I know of a couple of cases like that. The result of that is that the instrument department sometimes runs into antagonism on the part of the operating people, on account of furnishing equipment for which they have no use. I can't see the value of putting a chart and recording instrument where you know that you are going to get a straight line. If you do get a fluctuation of 10 or 15 degrees, it is not going to amount to anything.

O. J. LEONE: I can't feel like taking up the challenge, but I think I can give some justification for the use of charts in certain cases. That is on the basis of placing responsibility, as, for example, where one wants to check back to see what happened during the night. As an example, I know of at least one instance where a recording instrument was justified. A municipal water company had a long-distance water level recorder showing reservoir water level. Something happened to put the water main to the reservoir out of commission, and while it was being repaired, they had to use an old, smaller line in a roundabout direction. In the meantime, a fire broke out; immediately, the superintendent's political opponents accused him of inefficiency and said he had endangered the town because of insufficient water supply. They were unaware that in the superintendent's office was a new recorder which showed the exact reservoir level at all times. The superintendent was able to prove that there was sufficient water pressure at all times, and, as far as he was concerned, that one instance alone made the recorder pay for itself.

In other cases where we must contend with the human element, a recorder is often justified, if only for the psychological effect on operators. If it is known that a record will show what was done during the day, operators are more apt to keep on their toes. The record will also enable them to note trends, to anticipate changes, and to make correction for them. I know of cases where a recorder has been placed on a furnace and operators on nearby furnaces have tried to "show up" the instrument, and thereby better the efficiency of their own furnace.

There are a lot of other instances like these where the use of a chart is justified.

L. A. DEESZ: The maintenance of instruments is, to my mind, one of the critical things in a plant. I find that if the instruments or controls are installed which will allow a man to sit down and waste more of his time, then it is a good instrument and a good control. Conversely if it makes him think a little bit harder, then it seems to me that we have more trouble when we are trying to put the instrument and the equipment over. The point I am trying to make is that when first helpers, and others, think that automatic reversal equipment will take some of the responsibility off their hands, then to them it is a good instrument and a good control. But if it makes them do a little more work and a little bit more thinking, then you always have a lot more trouble in putting over the point.

We have tried to install only instruments that are necessary. I agree that in many cases they are installed where they are not necessary. I think that some of the controls are unnecessarily complicated.

We maintain a shop together with its equipment and necessary spares, and we don't like to have a zoological garden. We like to have our spares such that they will fit various instruments throughout the district. The idea of all kinds of instruments, all kinds of coils, all kinds of contactors, different voltages, different clocks, and so on and so forth, are all a nuisance to the instrument man and to the fuel department.

We find, as far as we are concerned, that we have fine cooperation with regard to the operators. In fact, sometimes I think it is too fine. You

get to the point where they become helpless after a while if the instrument does go out of commission and does not function properly. They call and seemingly demand help, forgetting that maybe for years and years they have operated a furnace without any instruments on it. I think that is a healthy situation.

All I can say is, simplify the instruments and control, don't overapply them; and I think the instrument industry will go forward.

C. L. DUDLEY: We do not follow exactly the course outlined by the speaker, but something near to it. We use care in instrument selection, of course, and the care of the instruments is ours. We have a shop where we clean, repair and test the instruments for the entire plant. If we wish an instrument, similar to one already in satisfactory use we will apply to that company again.

W. P. HILL: The gentleman spoke of what to do with these charts. In some cases, you may make a straight line at 250 F. Then, by rewinding the charts, we have used them over many times at varying temperatures, such as 650 F and 1250 F.

L. A. DEESZ: We have used our charts as many as four times by changing the color of ink.

L. F. COFFIN: I would like to enter a protest, as an operator, against the tendency towards more and more strip charts and less and less round charts. It may be necessary in certain types of pyrometers to have strip charts but the "run of mine" recording charts can and should be round in the greater majority of cases so that the supervisor can see at a glance, what has happened during a 24-hr period. If he has to unroll a strip chart, it is quite likely that in many cases, it will not be unrolled. Likewise in connection with his rounds of the mill, boiler house or power house, if the supervisor can see at a glance on a round chart, all that has happened in previous hours, his time is conserved and his knowledge of the operation increased. The tendency towards strip charts is being very much overworked, as I feel that they have much less practical value, even though in some cases, they may be slightly more accurate.

J. L. MILLER: I certainly would endorse Mr. Coffin's remarks. I believe the strip chart temperature instrument is considerably oversold for a great many applications. On a recent plant trip I overheard a soaking pit heater say to his plant combustion engineer, "You can see the full day's operation on those round charts and at a glance the boss has a very good picture of the equipment's operation." This human point of view of the man for whom we want the instrument to be an aid is of timely interest.

R. A. WEIKEL: I can only say, gentlemen, that the companies sell what you customers want. Enough users have wanted strip charts to force us to make strip charts, so that so far as overselling you, I don't like to think of it in that respect. I would rather think that we have strip charts available, and on some instruments, the circular charts are also available for your preference.

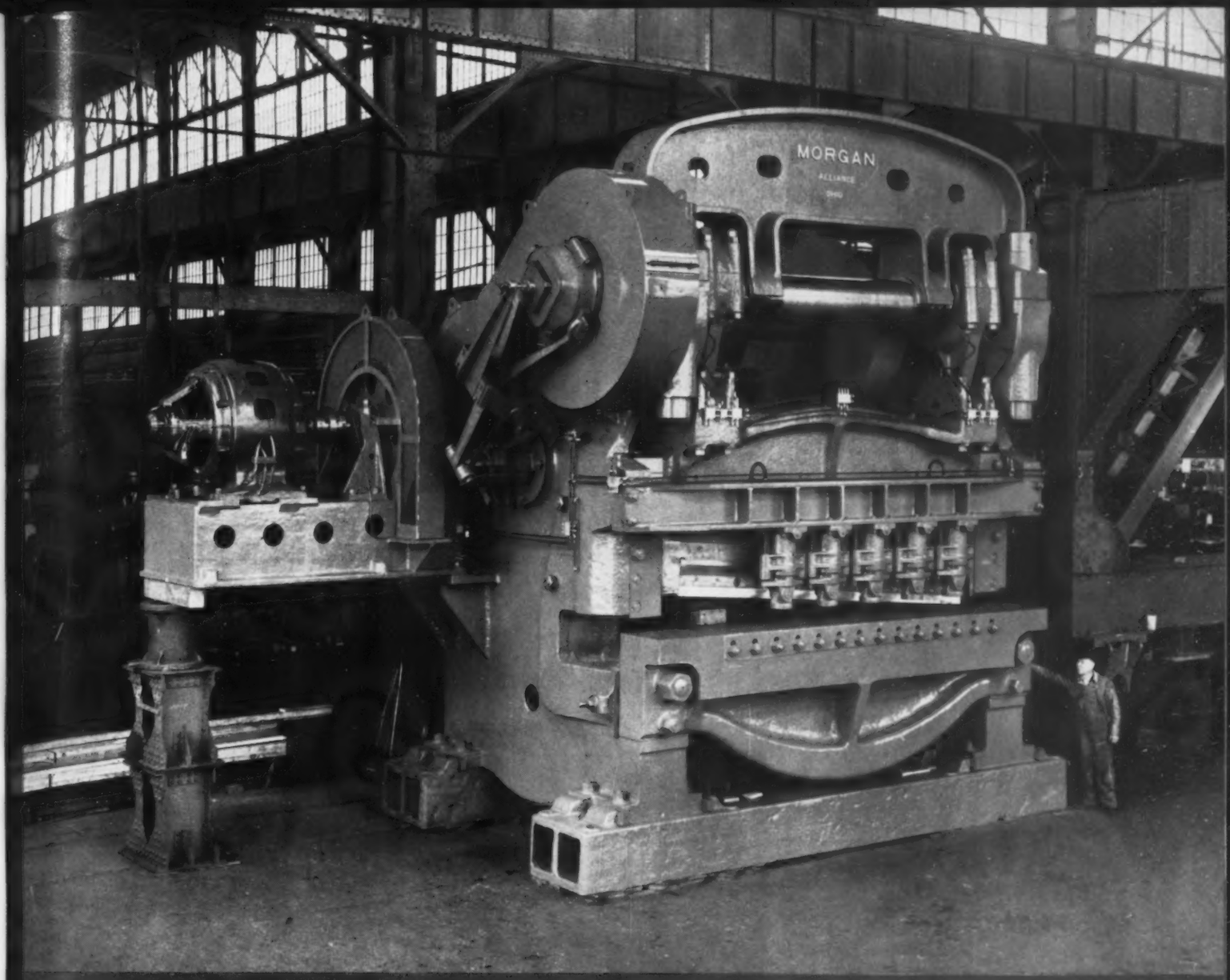
So far as accuracy is concerned, perhaps you are thinking of something like a potentiometer, which is inherently more accurate than a thermometer. Comparing the same type of instrument, the accuracy of the chart would not be any different, although the readibility would be increased with a strip chart having more pen travel.

R. I. GUMAER: A good many recording instruments and recording charts are necessary for other purposes than merely filing away. That is particularly true in measuring temperature. The recording chart may be valuable only at the moment, in the current period; for a few hours, that is, in showing the trend. The chart is important many times because it shows where the temperature is rising or falling, and at what rate it is rising or fallin. Once the operator knows that, the chart is unimportant, as far as the using of that chart for future records is concerned.

Now, in instruments of that type, the strip chart is perfectly all right. It doesn't have to be changed every day. It is available in instruments that make multiple records, many more records than you get on a circular chart instrument today. I think it certainly has its place on the temperature measurements, particularly of long cycle processes.

Otherwise, for single records, for no more than double records, on a process where we do want the information in the future, where we are going to go back to the records and see what has happened, I think the circular chart is certainly far superior. It is much easier to file, and much easier to see. It does have the objection that it has to be changed daily.

I do think that recorders are used, in many cases, simply to tell us how fast the measured quantity has changed. If you look at an indicating instrument, you can only learn the information if you stand and watch it for ten or fifteen minutes.



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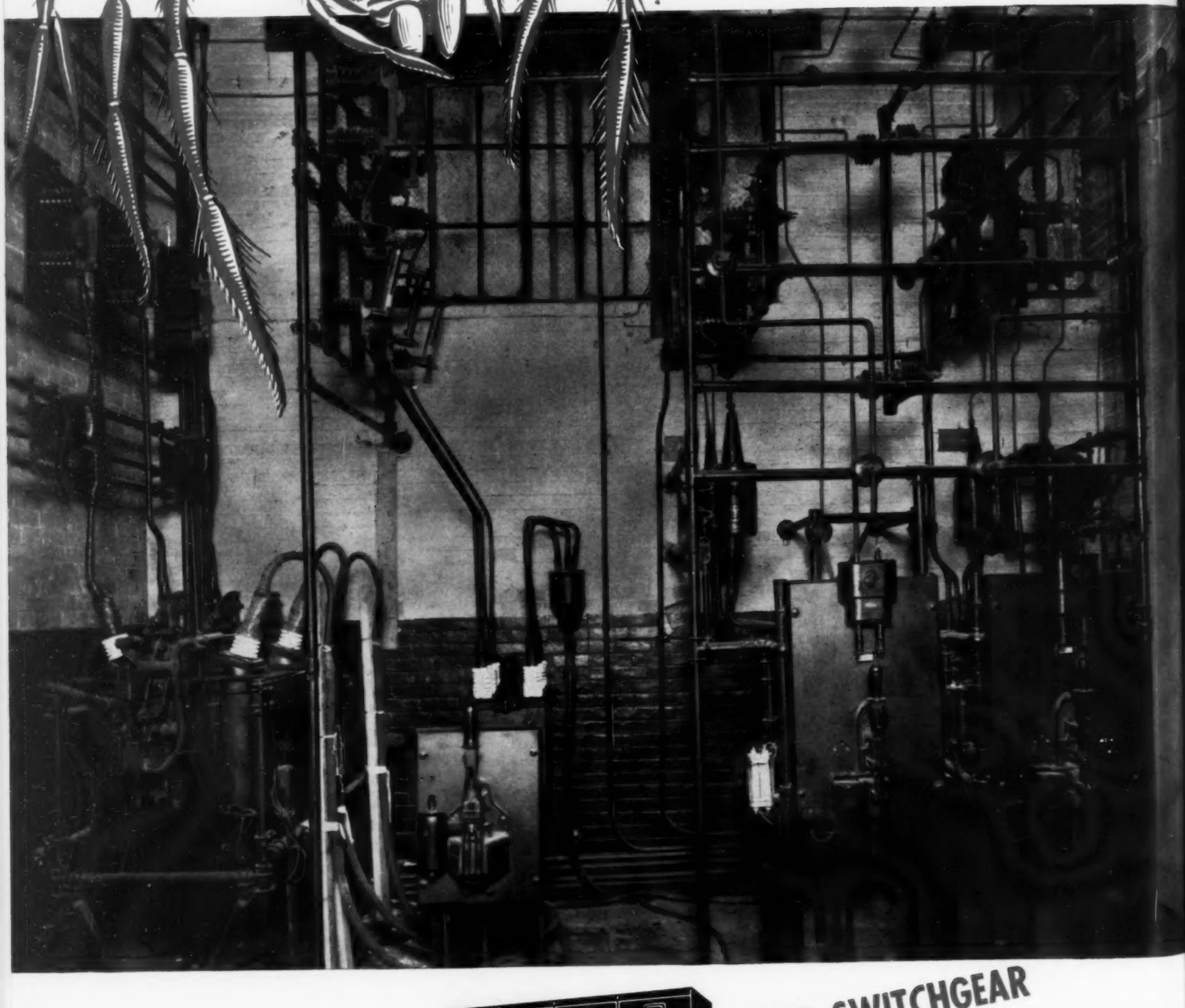

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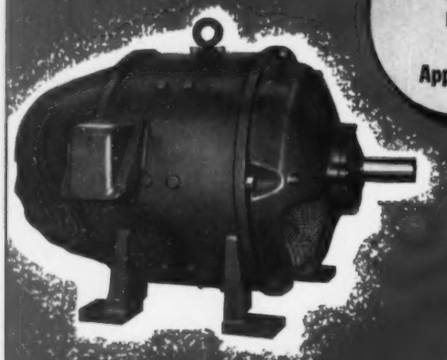
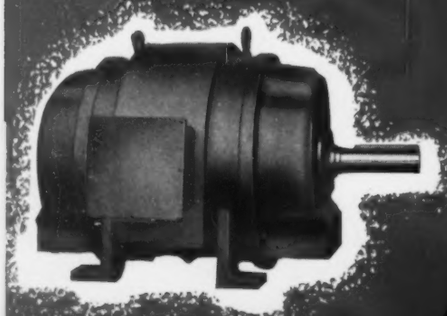


Type T Heavy-duty Reliance Motor for direct current with ball bearings.



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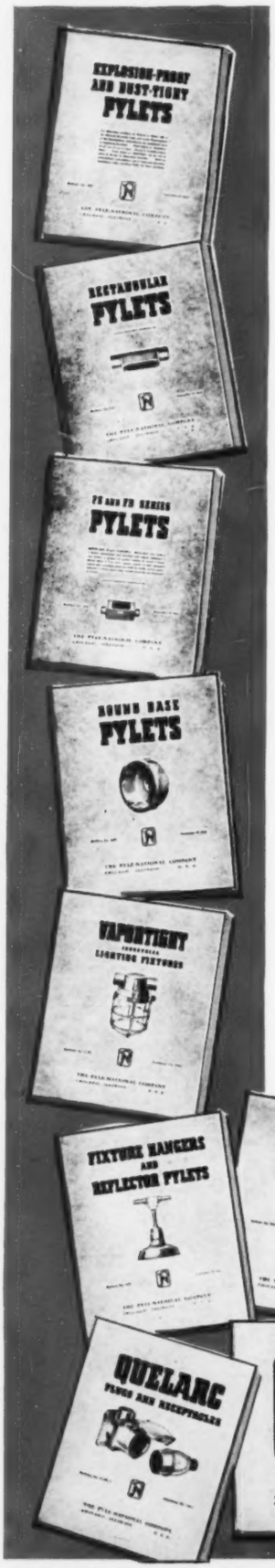

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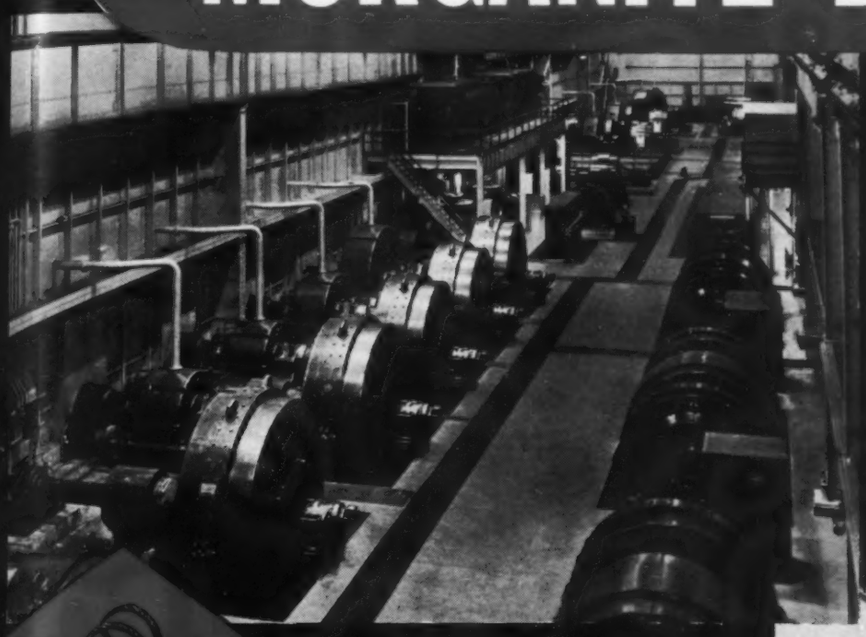

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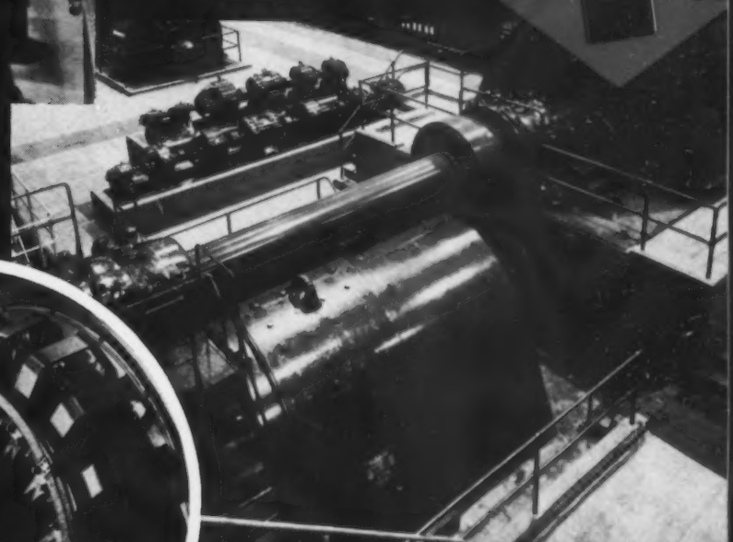

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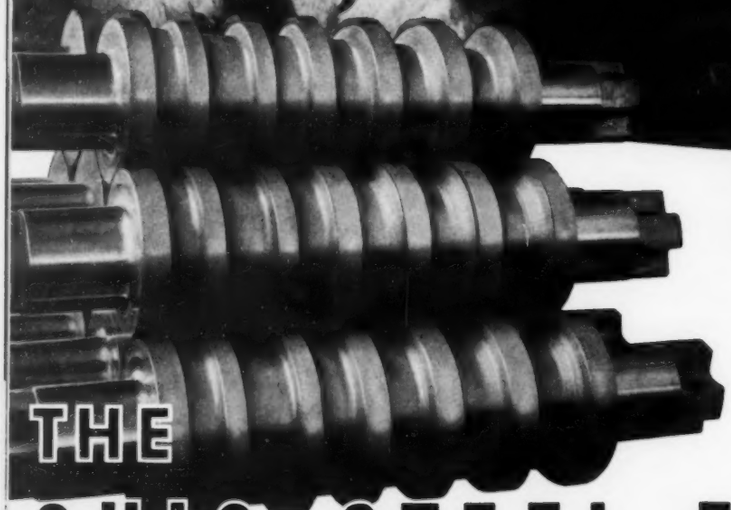

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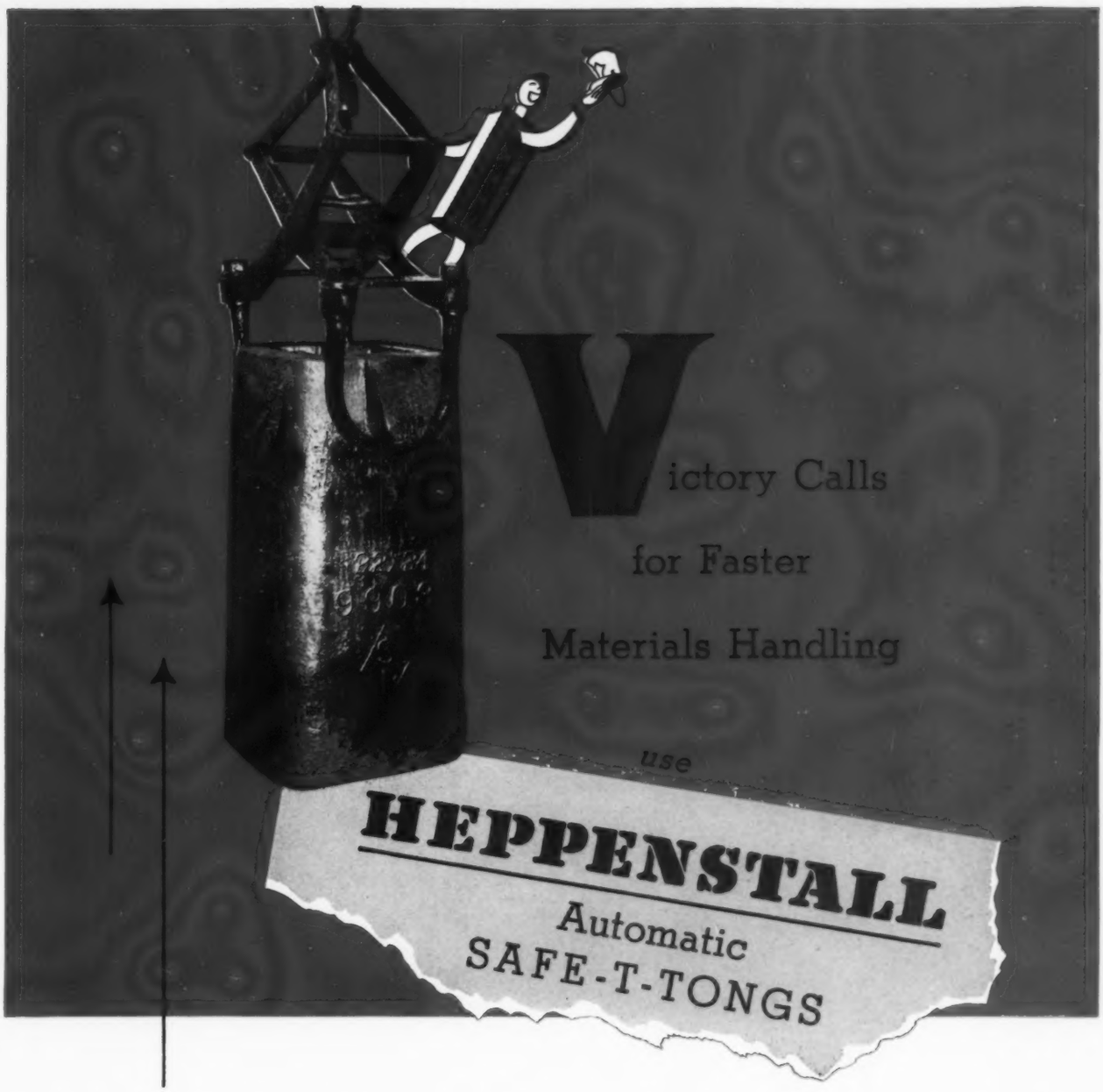

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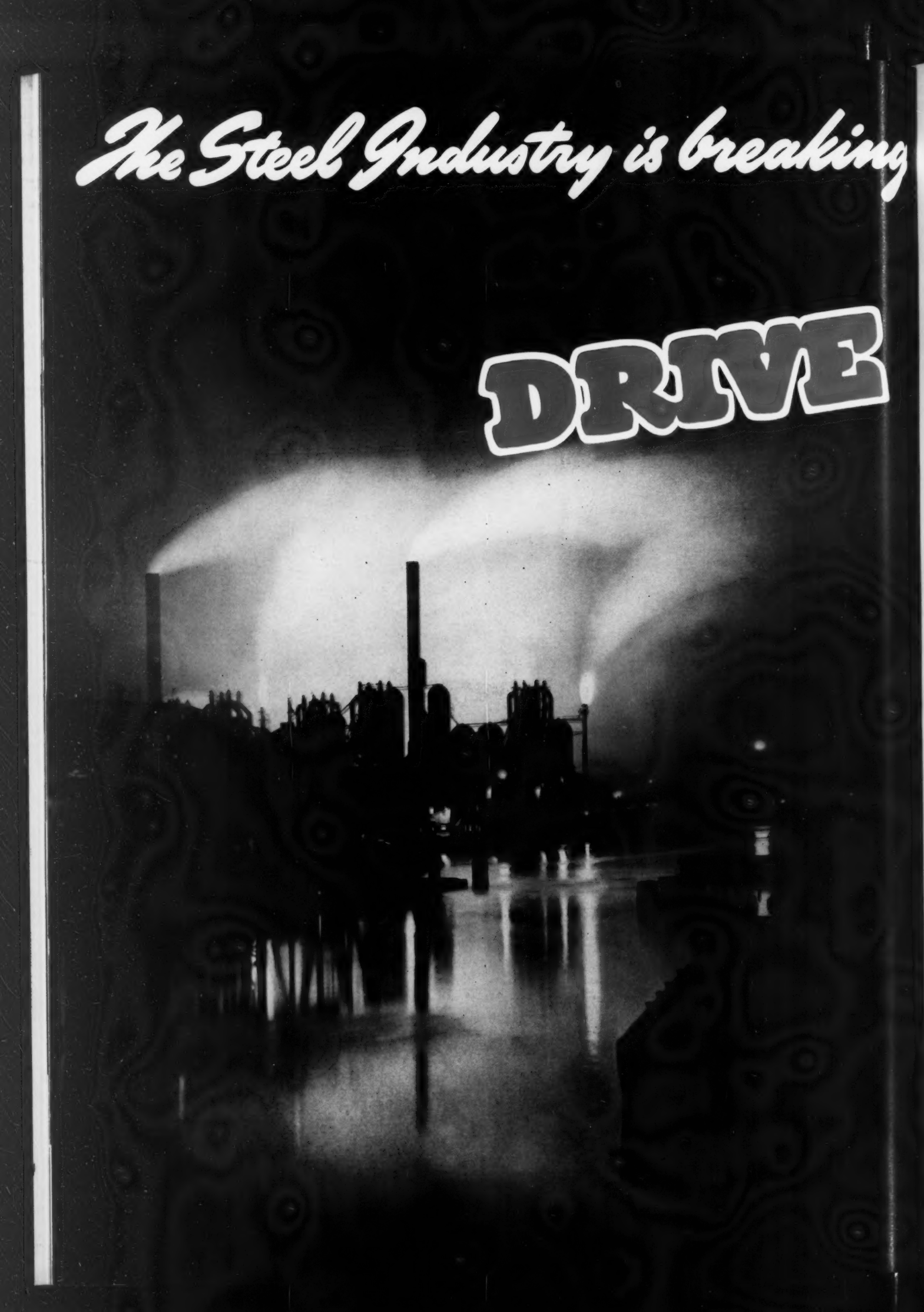

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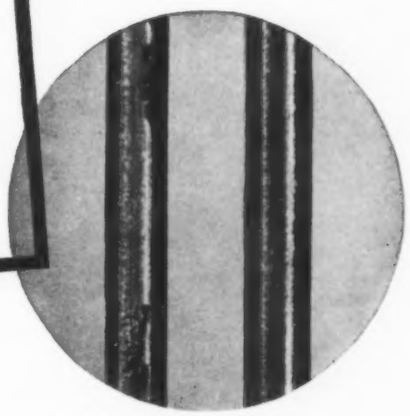
PITTSBURGH ROLLS DIVISION of BLAW-KNOX CO.—"Steel's Partner" • PITTSBURGH, PA.

OKOLOY COATING FOR CONDUCTORS OUTLASTS "TINNING" 2 to 1



● Enlarged section from tap water immersion tests on Okoloy compared with tin-coated rubber insulated wires. Note the corrosion and almost total loss of tin and pitting of copper. Note also that Okoloy is unaffected by the same exposure.

All copper conductors must be coated or covered to prevent direct contact between the copper and rubber insulation because:

❶ ***Copper is easily corroded by sulphur acids, formed from the action of moisture on the sulphur or sulphur compounds essential to vulcanization.***

❷ ***Rubber becomes contaminated when in direct contact with copper and deterioration results.***

● In dilute sulphuric acid, the tin coating (at left) is attacked immediately, while Okoloy (at right) is highly resistant. This illustrates what goes on under rubber insulation in the presence of moisture.

Protection through the use of tin, applied by passing the copper conductors through a bath of molten tin, dates back almost to the start of the insulated wire business. But "tinning" afforded inadequate protection, especially when wires were subjected to even small amounts of moisture. Failure of the tin coating too often has led to premature destruction of expensive cables.

OKONITE RESEARCH Hunts for Better Solution

So Okonite research chemists undertook to develop something better.

They found two sources of the trouble. First, the reaction products, formed when sulphur acids come in contact with tin, dissolve in the acids, so that, eventually, the copper itself is exposed, no matter how good the tin coating may be.

Second, the tin coating is seldom as good as it should be, because tin and copper readily form alloys at the temperature of the molten tin bath. The result is that instead of a pure tin sheath over a pure copper conductor, the coating consists of a series of copper-tin alloys, rich in copper at the base and rich in tin near the surface.

RESULT: OKOLOY, an improved protective coating

These findings showed tin to be inherently incapable of providing the necessary protection, so Okonite Research began work.

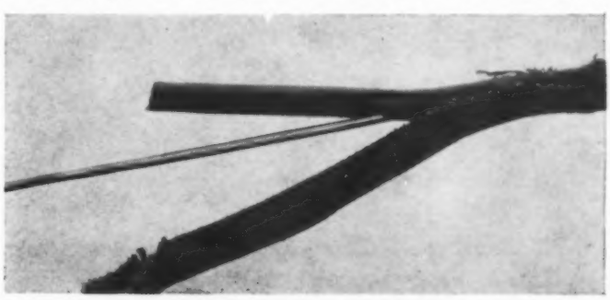
Of all the common metals, lead is least damaged by sulphur acids and it does not react with copper under the conditions encountered in coating wire.

These qualities made lead an encouraging prospect for a study which was successfully completed 13 years ago with the development of a new lead alloy called Okoloy, which adheres strongly to copper and surrounds it with an acid-resistant, flexible coating.

Severe laboratory tests show that under identical conditions, Okoloy protection will outlast the best "tinning" at least 2 to 1.

PROVED ON THE JOB SINCE 1928

Since 1928 Okonite has coated its rubber-insulated conductors with Okoloy. There have been many tests and installation results, such as the one illustrated below, to indicate that Okoloy has added years to the useful life of Okonite wires and cables.

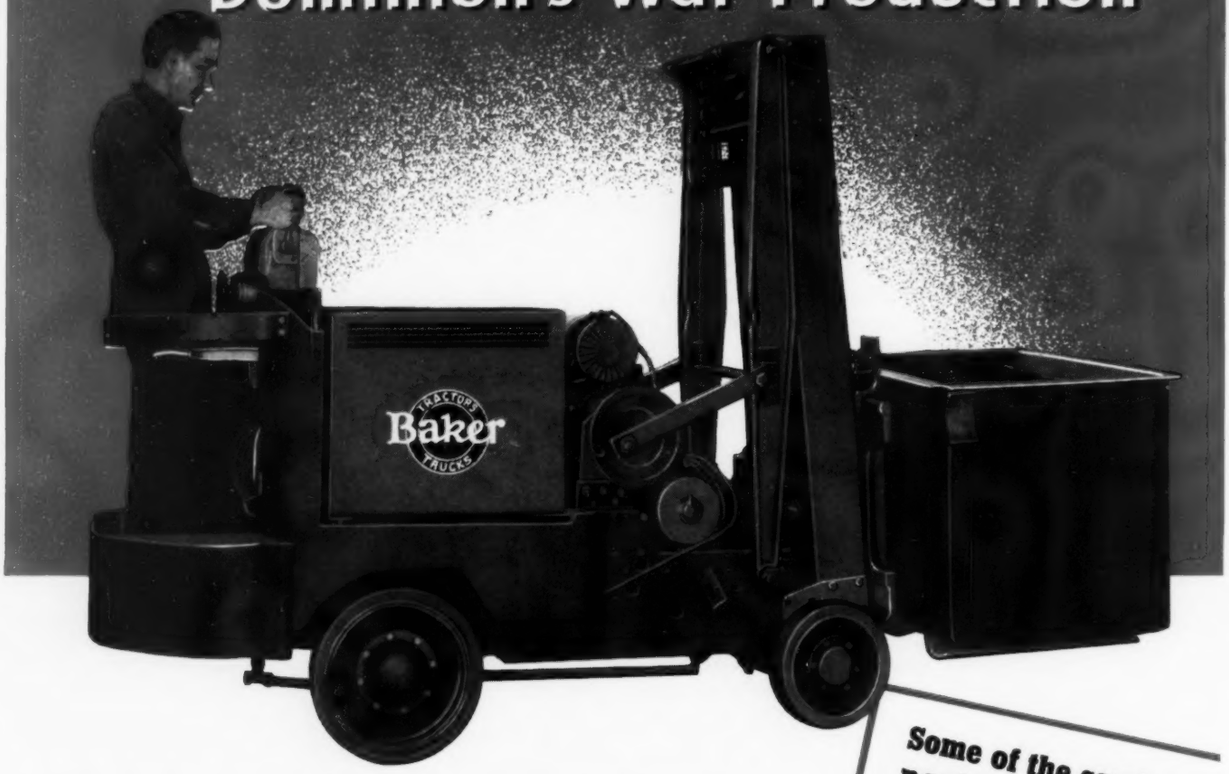


● Section of Okoloy-coated wire removed for examination after 13 years of service along right-of-way of major railroad system, where it was continuously exposed to weather and to highly corrosive sulphur fumes. Note perfect condition of Okoloy coating and Okonite insulation.

THE OKONITE COMPANY
Offices in principal cities
Passaic, N. J.

Specify OKONITE INSULATED WIRES AND CABLES

BAKER TRUCK *speeds*
Dominion's War Production

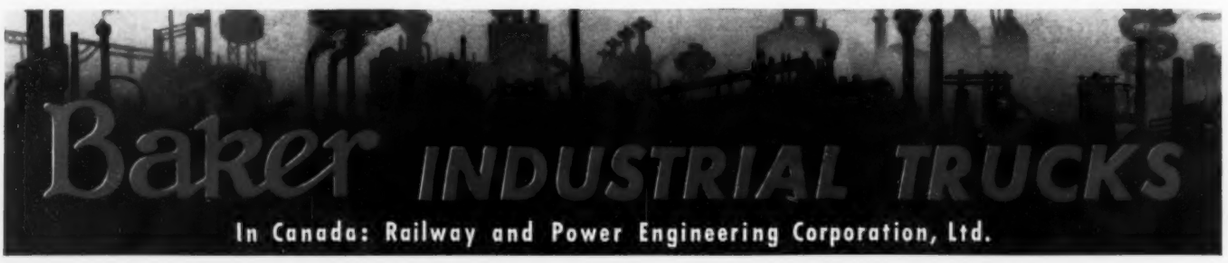


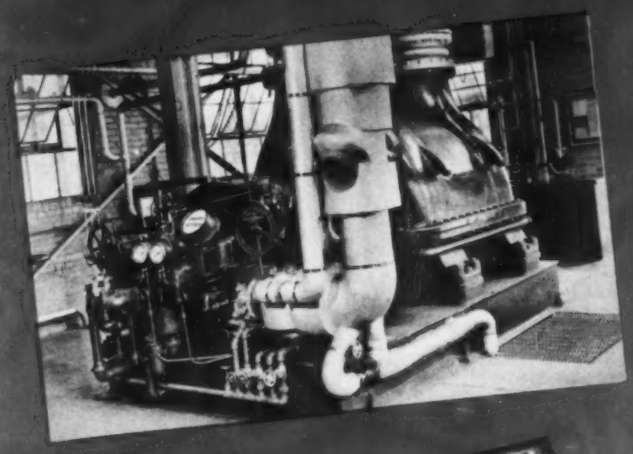
● At the Hamilton, Ontario tin plate mill of Dominion Foundries and Steel, Ltd., this Baker Fork Truck is a vital production tool. Savings in time and man-power are reflected in the mill's excellent production record. •••• Current demands on the entire American Steel Industry are emphasizing the importance of adequate material handling facilities. The Baker representative near you is prepared to help you make the most of your present facilities. You can call him, or write us direct.

Some of the services performed by this BAKER TRUCK

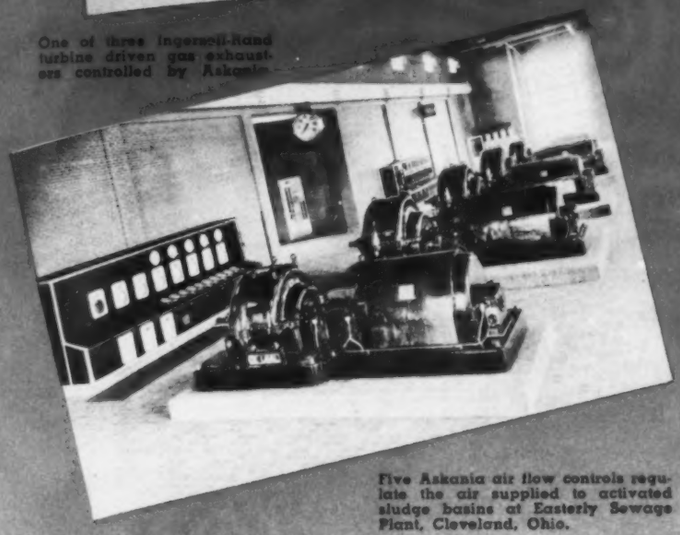
- Handles Sheet Packs in mill
- Stacks Sheet Packs in storage
- Loads Sheet Packs into cars
- Handles Coils in mill
- Stacks Coils in storage
- Handles Boshes
- Handles other heavy materials

BAKER INDUSTRIAL TRUCK DIVISION *of the Baker Raulang Company*
2166 WEST 25TH STREET • • • • CLEVELAND, OHIO





One of three Ingersoll-Rand turbine driven gas exhausters controlled by Askania.



Five Askania air flow controls regulate the air supplied to activated sludge basins at Easterly Sewage Plant, Cleveland, Ohio.

Protect your prime movers with ASKANIA CONTROL

MORE than ever now, you need control equipment that will not only give you accurate control, but complete protection of your investment. Askania control does this through the simple hydraulically operated jet pipe principle.

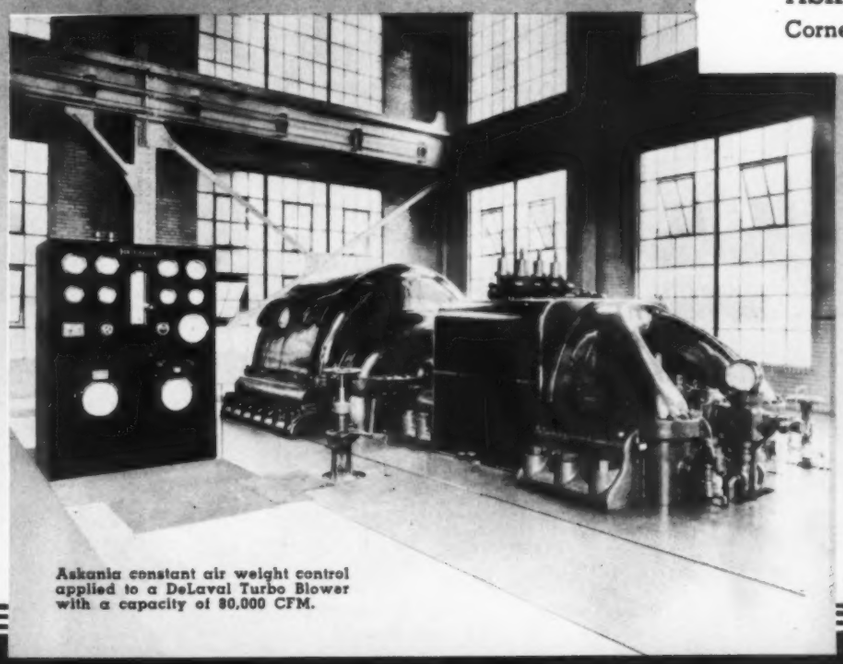
Here are a few of the many applications that have proved the value of that better operation that comes with Askania control.

- Turbine Bleeder Control
- Turbine Back Pressure Control
- Turbo-Blower Control
- Turbo-Exhauster Control
- Turbo-Booster Control
- Pressure, Flow and Suction Control for Parallel Operated Units
- Speed and Governor Control
- Volume and Pressure Control to Prevent Pumping

Only the best equipment has a place in America's War Industry, and when it comes to automatic control for Prime Movers, that means *ASKANIA*.

Write for information on any problem involving pressure, flow, proportioning or boiler combustion control.

ASKANIA REGULATOR COMPANY
Corner 16th and Michigan, Chicago, Illinois

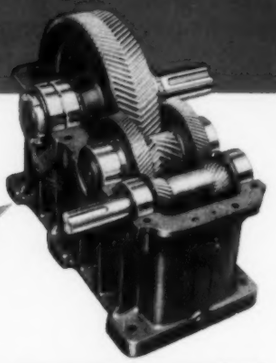


Askania constant air weight control applied to a DeLaval Turbo Blower with a capacity of 80,000 CFM.

4,600 H. P. Allis-Chalmers Turbo Blower equipped with Askania control.

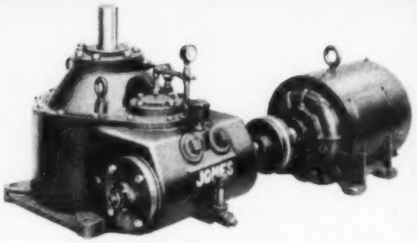
ASKANIA
REGULATOR CO. CHICAGO
AUTOMATIC CONTROL

To help you SPEED PRODUCTION



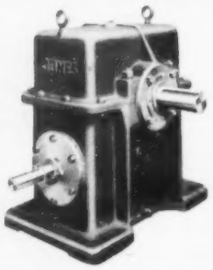
HERRINGBONE REDUCERS

Available in single, double and triple reduction types in a wide range of ratios and ratings.



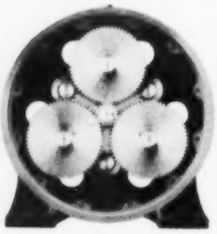
WORM-HELICAL SPEED REDUCERS

A versatile line of double reduction units for agitators, mixers or other applications requiring a vertical shaft drive.



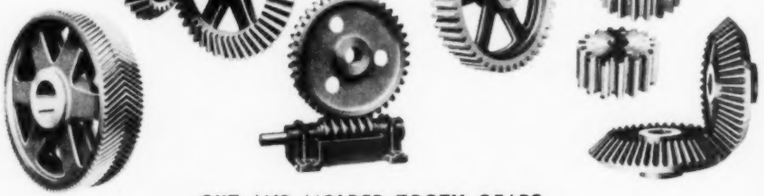
WORM GEAR REDUCERS

Built in light and heavy duty types and in various styles to suit the conditions.



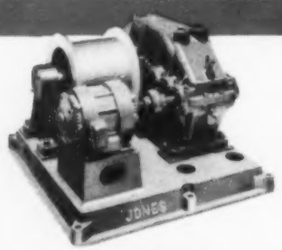
SPUR GEAR REDUCERS

Concentric straight line drive in single and double reduction units.



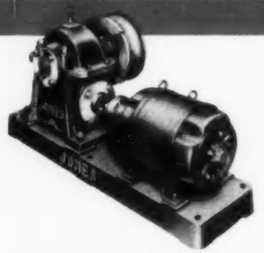
CUT AND MOLDED TOOTH GEARS

Jones gear cutting practice represents the accumulated technical knowledge of 50 years backed by the finest gear cutting equipment and craftsmanship.
The line covers cut tooth spur, helical, herringbone, worm, bevel, and mitre gears of high test cast iron, steel, bronze, or non-metallic material. An extensive line of patterns is also available for high test cast iron molded tooth, spur, bevel and mitre gears.



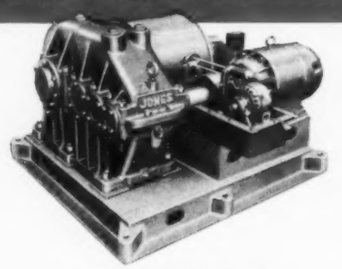
CAR PULLERS

These car pullers are built by Jones as complete units with motor included if desired, or with base to take purchaser's motor. The cable drum is driven by a Jones double or triple reduction Herringbone speed reducer and the control station may be located at a point to give the operator a clear view of the tracks and spotting positions.



DOOR HOISTS

The Jones Door Hoist is a simple, compact and sturdy heavy duty worm gear driven unit that has been widely used in the steel industry for handling furnace doors. It is also applicable to other services where doors of various types must be opened and closed and where it is desired to avoid the complications of limit switches.

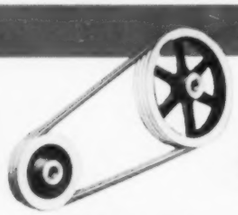


SKIP HOIST DRIVES

Jones Skip Hoist Drives are equipped with all the modern protective devices such as cam or nut type limit switches, solenoid or disc type brakes and slack cable switches. Drives are standard Jones Herringbone Speed Reducers.

PULLEYS

Jones pulleys are machine molded, poured of high test cast iron, and are accurately finished and balanced. Single arm, double arm, multiple piece and extra heavy conveyor pulleys and flywheels can be supplied.



V-BELT SHEAVES

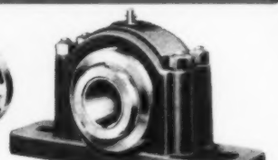
Made of high test cast iron. Sheaves for "AB" light duty combination and "C" belts in stock with keyseated bushings. Standard and special sheaves for all industrial belt sections made to order.

CLUTCHES

Built for a broad range of shaft sizes and ratings in both enclosed and open types for sleeve and coupling work. In addition they are available in a line of friction clutch pulleys. This clutch modification is also used with gears, V-belt sheaves or sprocket wheels.

COUPLINGS

High and low speed flexible couplings, flange, keyless compression, ribbed and jaw clutch couplings.



PILLOW BLOCKS

Jones Pillow Blocks have double row Timken Roller Bearings locked firmly to the shaft by means of a tapered split steel adaptor and clamp nut. Effective seal retains lubricant . . . easily removed from shaft.

HANGERS

Jones drop hangers, post hangers and bracket hangers are strongly reinforced with arch bracing. Free universal adjustment. Feet are ground.

W. A. JONES FOUNDRY & MACHINE COMPANY
4401 Roosevelt Road, Chicago, Illinois

Jones

BULLETIN No. 80

"Jones Drives for Industry" may be helpful in giving you a complete picture of the Jones products, engineering services and manufacturing facilities that are available. Your request will bring a copy.

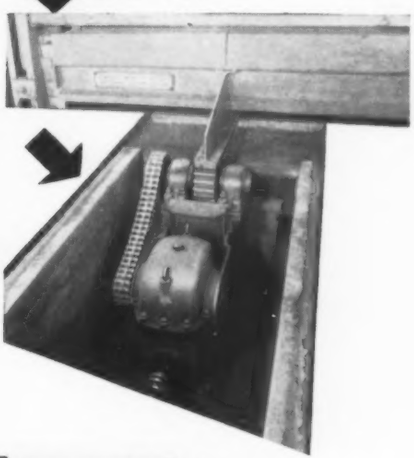
HELPING TO KEEP STEEL PRODUCTION

"ON THE MOVE" WITH LINK-BELT CONVEYORS...DRIVES...

MECHANICAL TRANSMISSION EQUIPMENT

BELT CONVEYORS Two of three L-B belt conveyors which handle coke breeze to storage at a well-known Canadian steel plant. Link-Belt designs offer the best in belt conveyor equipment for handling a wide range of materials.

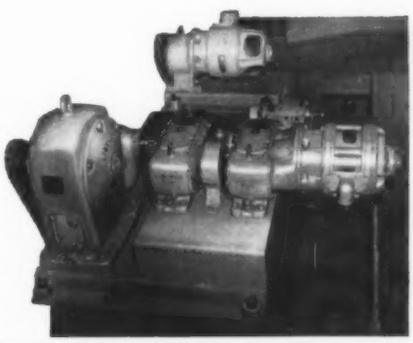
FURNACE CAR HAUL DRIVES · The movement of cars in and out of annealing furnaces at Dominion Foundries & Steel, Ltd., is accomplished with 9 compact, efficient, positive Link-Belt drive arrangements of this kind. Each consists of worm gear reducer, roller chain drive, Friction Fighter roller bearings, flexible coupling and spur gear rack and pinion.



ROLLER CHAIN DRIVES AND ROLLER BEARINGS · Live rolls on charging and discharging ends of hardening and tempering furnaces as well as live rolls in the furnaces at Dominion Foundries and Steel, Ltd., are equipped with over 500 Link-Belt Friction Fighter Roller Bearings and operated by Link-Belt Silverlink Roller Chain Drives.

PORTABLE CONVEYOR handles brick for rebuilding open hearth furnaces. It is placed in position by an overhead crane and when not in use is stored on two beams beyond firing floor.

• Today, more than ever, Link-Belt products are playing a vital part in the Herculean production program of the steel industry—aiding it to produce at ever-greater speeds — the urgently needed sinews of victory.



POSITIVE DRIVES One of three drive arrangements for live rolls which move steel plate through hardening and tempering furnaces; consisting of Link-Belt P.I.V. Gear Variable Speed Transmissions, Worm Gear and Motorized Helical Gear Speed Reducers, and Silverlink Roller Chain Drives.

LINK-BELT COMPANY 0817

Chicago Indianapolis Philadelphia Atlanta Dallas Pittsburgh
Cleveland Detroit San Francisco

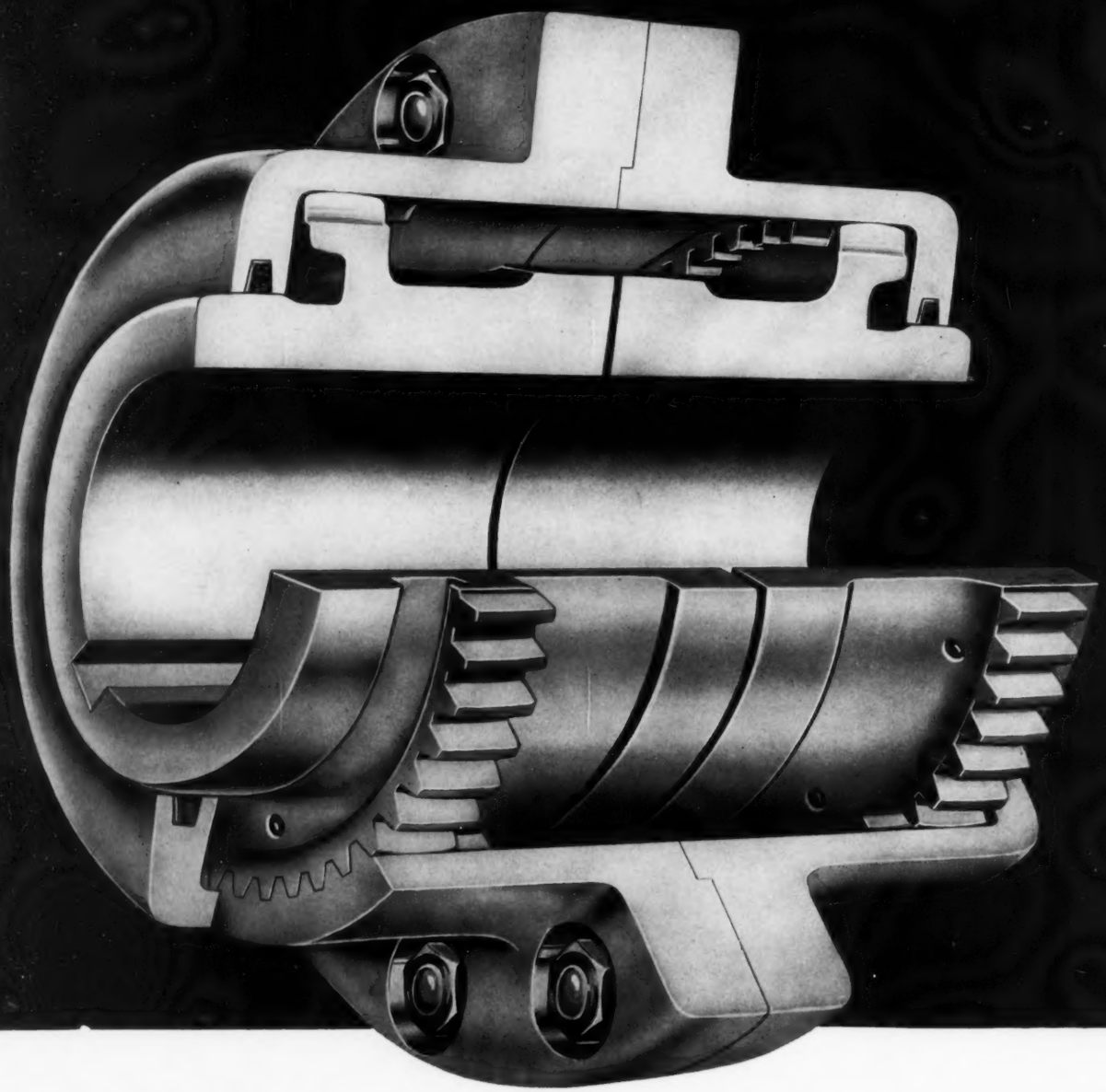
Other offices, warehouses and distributors in principal cities.

IN CANADA: Link-Belt Limited, Toronto, Montreal, Vancouver, Swastika

LINK-BELT EQUIPMENT Complete line of Chains for transfer tables, coil conveyors, furnace conveyors, feeder and catcher tables, sheet pilers, draw bench and other equipment . . . Elevators and Conveyors of all types . . . Vibrating Screens . . . Dryers and Coolers . . . Skip Hoists . . . Car Spotters and Haulage Systems . . . Portable Conveyors and Bucket Loaders . . . Silent and Roller Chain Drives . . . Speed Reducers . . . Variable Speed Transmissions . . . Sprockets . . . Elevator Buckets . . . Gears . . . Clutches . . . Couplings . . . Friction Fighter Self-aligning Ball and Roller Bearings . . . Babbitted Bearing Units . . . Base Plates . . . Take-Ups, etc.

LET'S GO! U.S.A. KEEP 'EM FLYING!

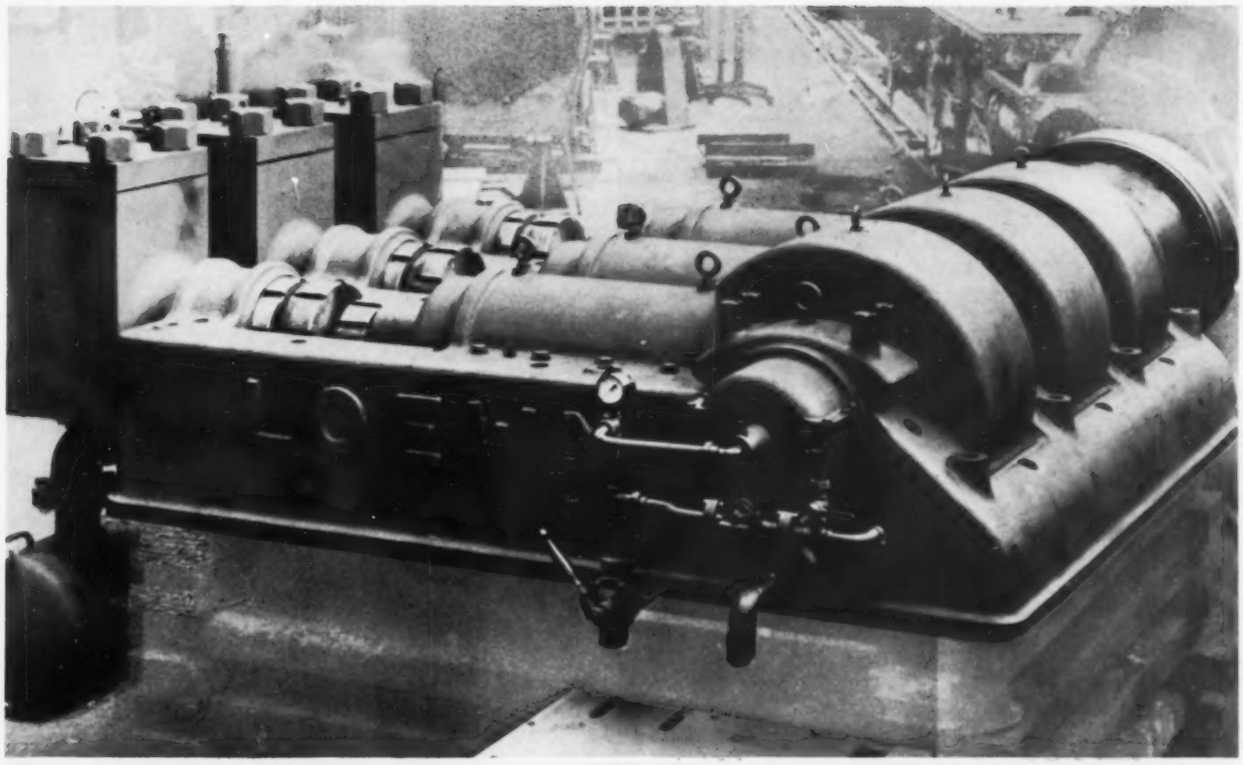
POOLE



A COPY OF CATALOG GIVING FULL DESCRIPTION AND ENGINEERING DATA SENT UPON REQUEST.

FLEXIBLE COUPLINGS

POOLE FOUNDRY & MACHINE COMPANY WOODBERRY, BALTIMORE, MD.



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CANADIAN REPR. OFFICE
678 SUN LIFE BLDG.
MONTREAL

YES, IT'S ONE OF "OUR BOYS" writing—but he's not being prejudiced. Hyatt's *do* play a major part in Army and Navy equipment ... in tanks and guns and planes and ships ... in the machines that make the machines of war. Everywhere, every day, precision-made Hyatt Bearings are serving well in America's drive toward victory.

Our young soldier's buddies in Department 9 at Hyatt are justly proud of him—and he can be equally proud of them. For they are soldiers, too ... in the front lines of industry ... working with might and main, day and night ... keeping a steady flow of vital parts for the fighting machines that our fighting men are using with such telling effect! Hyatt Bearings Division, General Motors Corporation, Harrison, N. J., Chicago, Pittsburgh, Detroit and San Francisco.

THE 50TH YEAR OF **HYATT** ROLLER BEARINGS

STEEL INDUSTRY SETS ALL TIME RECORDS

▲ Always a favorable month for the setting of new production records in the steel industry, March, this year, brought a number of outstanding achievements from various plants throughout the country. Coming on the heels of Donald M. Nelson's request for increased production, these records bespeak the really fine work which the iron and steel industry is doing.

All daily and monthly world records for blast furnace production were broken during the month of March by Great Lakes Steel Corporation's Zug Island furnace, with a straight ore burden production for the month of 43,478 tons and the high daily production of 1608 tons on March 31, George R. Fink, president, reported recently. Great Lakes Steel Corporation is a subsidiary of National Steel Corporation. The previously widely acclaimed world record of 41,782 for one month was set a few weeks ago in Pittsburgh.

The Great Lakes furnace established its world record for the output of pig iron with a consumption of less than 1700 lb of coke per ton of iron produced. This is a decrease of about 5 per cent in coke consumption and represents conservation of a vital war material. This is the second record set by the Great Lakes furnace, one of the largest in operation any where. The furnace was built and blown in on December 9, 1941, having been constructed in about one-third of the time normally required for the building of a blast furnace.

"Every tap for a Jap" was the slogan of the men as they neared the record and ran their last day's score to an unheard of tonnage. Almost all have sons, brothers and other relatives in the Army, Navy and Air Force and they set out to back them up with a record production of vitally needed steel. Great Lakes Steel Corporation, a unit of National Steel Corporation, is almost 100 per cent on war orders.

The greatest production of steel for one month in the thirty-one years the Middletown Division of the American Rolling Mill Company has operated was recorded at mid-night Tuesday, March 31, 1942, by the blast furnace,

NEW COMPANY TO MAKE SEAMLESS TUBING

To increase the production of seamless tubing in alloy and stainless steels essential to the war effort, United States Steel Corporation has created a new subsidiary company, Tubular Products, Incorporated. This company, which will begin operations shortly, has acquired the existing plant of National Tube Company at Gary, Indiana.

Benjamin F. Harris, president of National Tube Company, will be president of Tubular Products, Inc. E. N. Sanders is vice-president of the new company with headquarters at Gary. The other officers, who will also have their headquarters at Gary, are A. Gordon Patterson, secretary and treasurer; E. M. Moore, comptroller; R. W. Wire, manager of sales; L. W. Mason, manager of purchases.

The principal products of the new company will be stainless and alloy tubing for the Army, Navy, and Maritime Commission requirements, including tubing for aircraft structures, motor parts, bearings, tank tractor tubing, oil refinery tubing, and many other applications.

Seated, left to right: E. N. Sanders, B. F. Harris and L. W. Mason. Standing, left to right: E. M. Moore, A. Gordon Patterson and R. W. Wire.

open hearth and blooming, bar and strip mill departments. The record is more impressive in view of the hand-to-mouth supply of scrap iron that has harrassed operating officials of the steel company.

At Weirton the joint labor-management committee of the Weirton Steel Company announced that the plant's 12 stationary open hearth furnaces, in March, produced 153,569 net tons of steel ingots, exceeding the previous plant record by 13,569 tons The committee has received radioed congratulations from General MacArthur on the "magnificent record . . . on behalf of our beloved country."

The United States Steel Corporation announced that the subsidiary companies of the corporation in March established all time records in producing nearly 2,000,000 tons of blast furnace products and almost 2,600,000 tons of steel ingots and castings. A new record in production of plates, vital to the war effort, was also made by the United States Steel subsidiaries in March when approximately 300,000 tons rolled off these mills.

Carnegie-Illinois Steel Corporation, one of the subsidiaries, established a new world's record for plate production at one of the corporation's units in the Pittsburgh area. The world's record was made by the crew of a 100-inch continuous type plate mill, which, in turning out 72,530 tons exceeded its own previous record by over 9000 tons.

Two additional plate mills scored records for units of similar size. A 140-in. 3-high single stand mill, which in January had established a new record, exceeded the January figure by 2000 tons to produce 34,831 tons of plates, and a 48-in. universal plate mill, in producing 22,200 tons in March, also topped its previous record, made in January, by 2000 tons.

In calling attention to these records, it was pointed out that numerous operating records were broken in plants of the corporation during March and that the whole organization is bending every effort to produce more war goods now. For example, a Pittsburgh district blast furnace located at Braddock, Pennsylvania, produced 42,131 net tons of pig iron in March, exceeding by several hundred tons the world's record established in January by the corporation's Carrie Blast Furnace No. 3. The

View of main erection room where Navy "E" was awarded to Morgan Engineering before an assemblage of all their employes.

Morgan Engineering Awarded Navy "E"

▲ Patriotic and deeply inspiring ceremonies marked the presentation, April 2, of the greatest United States Navy award to the Morgan Engineering Company — the traditional Navy "E" for all-out production in 1941.

Amid a setting that included an appropriately decorated improvised stage, and the assembly of all the company's employes and executives in the main erection room of the giant plant, the Navy "E" pennant was tendered President A. F. Morris by Captain E. A. Lofquist, chief of staff of the Ninth Naval District at Great Lakes, Illinois.

To each employe of Morgan went a Navy "E" button, significantly carrying the tribute through the entire ranks of the personnel. The "E" lapel badges were accepted on behalf of all the employes by the deans of the workmen, John R. Miller and Charles Schultz, with combined service records of more than 120 years.

Captain E. A. Lofquist, chief of staff of the Ninth Naval District, Great Lakes, Illinois, presenting the "E" pennant to A. F. Morris, president of Morgan. At the right is C. L. Wilson, commander of C. C. Weybrecht American Legion Post, whose color guard posted the flag.

Braddock and Carrie furnaces are of equal size and capacity.

Operating well above 100 per cent of capacity, Republic Steel Corporation smashed production records during the month of March that were only made last October. October records in turn broke records made in March, 1941. In its drive to turn out increasing tonnages of iron and steel for armament purposes, Republic exceeded its previous record highes in both pig iron and steel ingot production. A new mark was also set in the all-important electric furnace steel output, so essential in the manufacture of every tank, airplane, armored truck, scout car and naval vessel used by our armed forces.

Departmental records were broken in every one of Republic's steel-producing districts. An accepted world's record for pig iron production from a single blast furnace was also toppled. Previous output of urgently needed ship plate was substantially exceeded as was the output of the corporation's bar mills.

"Republic has repeatedly broken what we considered unbreakable records," said C. M. White, vice president in charge of operations. "In the old days production records frequently stood unchallenged for years but

IMPROVED CONTROL FOR FURNACE DOORS

▲ A revolutionary improvement in furnace door lifts has been announced by the Fred J. Ryan Company, Philadelphia, Pennsylvania. Through the combination of Ryan industrial furnace engineering service and the extensive manufacturing experience of the Globe Hoist Company, the Globe-Ryan industrial furnace door lift now offers industry a new and more practical method of electric door control and operation.

While the Globe-Ryan unit is primarily recommended because of its compactness, simplicity and accuracy in use, one of its outstanding advantages is the elimination of one of the most objectionable jobs on the furnace floor, namely, the slow lifting by hand of a door with the operator being exposed to heat radiation and the charge being exposed to the chilling effect of the draft caused by the slow door movement. The Fred J. Ryan Company will be glad to send complete information to all interested companies.

AWARDED CONTRACT FOR CONTROL SYSTEM

▲ Surface Combustion, Division of General Properties Company, Inc., has been awarded a contract to supply a Kathabar moisture control system for furnishing dry blast to the new blast furnace of the Republic Steel Corporation, Alabama City, Alabama. The Kathabar system is to treat 90,000 cfm of air and is to operate at one, two or three grains of air moisture, depending upon season. Such flexibility of operation provides for constant uniformity of product throughout the year.

The Kathabar system will require only one 50 hp motor for power, and no materials used in the equipment are vital to war industries. Officials have estimated that 10 per cent in-

Steel Mill PLATE STAMPING

Slab section and sheared plate identification is rapidly stamped with Matthews Plate Stamping Holders. Of tool steel construction, they are light in weight and very durable. Easy to handle! The "Shepherd-Hook" holding device eliminates "wrong-side-up" stamps. Stamps cannot fall out or fly out on rebound from hammer blows. Safe, rapid and definite stamping.

Steel stamps are held in place by a properly tempered "Shepherd-Hook." They are quickly and easily changed. Holders are made for any required quantity of stamps. Write for literature and prices. State character size and number of characters to be stamped.

Same holder made for marking pipe, rounds, etc.

JAS. H. MATTHEWS & CO.
3942 FORBES ST. ∴ PITTSBURGH, PA.
New York—Chicago—Phila—Boston—Detroit—Newark—Syracuse
DISTRICT SALES OFFICES - CLEVELAND - HARTFORD - BIRMINGHAM

IMO MOVE OIL

LARGE CAPACITY...
in small space
•
De Laval-IMO Oil Pumps

for lube and fuel oil and for hydraulic pressure service pack great capacity into small space. The one shown, delivering 700 g. p. m., occupies only 30 in. square of floor space. It has only three moving parts and runs at standard motor or turbine speeds. Built in all capacities and for all pressures.

Ask for Catalog I-88

IMO PUMP DIVISION
of the De Laval Steam Turbine Co.
Trenton, New Jersey

crease in furnace capacity, due to the application of Kathabar dry blast, would supply the necessary materials for the equipment in one day's time. Due to the simplicity of the system, the entire installation will be complete in less than 90 days' time.

Although this installation represents the first for blast furnace application, Kathabar installations for cupola dry blasts have been in operation since 1938. To date, there is a

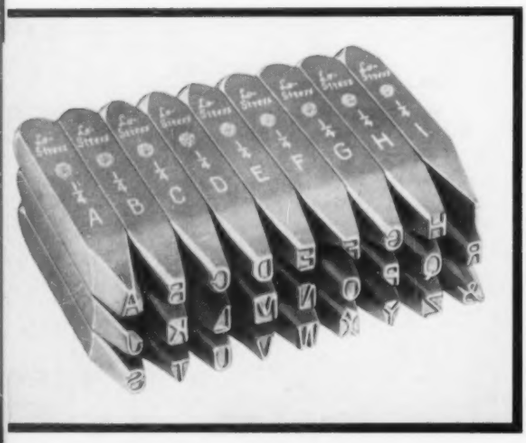
STEEL STAMPS MARK AIRCRAFT TUBULAR PARTS

▲ "Lo-Stress" . . . round face characters are designed for marking parts placed in torsional or tensile stress. Also, where internal stresses of heat-treated steel may break out at point of marking on surface. The rounded impression and special character design of "Lo-Stress" stamps provide the minimum stress set up by permanent marking.

The new character which has been developed by the James H. Matthews and Company, Pittsburgh, Pennsylvania, has been carefully engineered and designed for safe marking of aircraft, tubular or heat-treated parts, and is available in letter and figure stamps, hand stamps, stamping and roller dies, and in steel type for use in type holders.

For ordering, it is necessary that they know size of character desired, and the application in which stamps, dies or type holders are to be used. A sample of part to be marked, should be sent if possible.

The stamps feature round face characters designed for marking parts placed in torsional or tensil stress.



VAPOR-TIGHT LUMINAIRE FOR MERCURY LAMPS

▲ Especially adapted for extreme service locations, such as steel mills, foundries, chemical plants or wherever acid fumes, dust, smoke or excessive moisture is present, a new vapor-tight Millite luminaire for incandescent or mercury lamps is announced by the Westinghouse Lighting Division, Cleveland, Ohio. Because of its weather-proof construction, the unit can be used satisfactorily for outdoor applications.

Consisting of three parts, a porcelain enameled steel reflector available in several sizes, a socket assembly, and a hinged glass cover, the unit is arranged for conduit mounting. Reflectors for 300 and 500 watt sizes are made from 19 gauge iron sheet, and the 400, 750, and 1000 watt sizes are from 18 gauge.

Motor Temperatures Rise As Tonnage Increases

Increased production of steel demands overtime operation of motors and other electrical equipment, often for periods ranging from 18 to 24 hours a day without letdown.

Increased motor operating temperatures resulting from overtime operation or temporary overloads frequently leads to premature breakdown. Many leading mills insulate their motors and other electrical equipment with CHINALAK Black Baking Varnish because they have found that the heat endurance and heat resistant properties offered by CHINALAK are high enough to permit sustained operation long after the failure of electrical equipment treated with other baking varnishes.

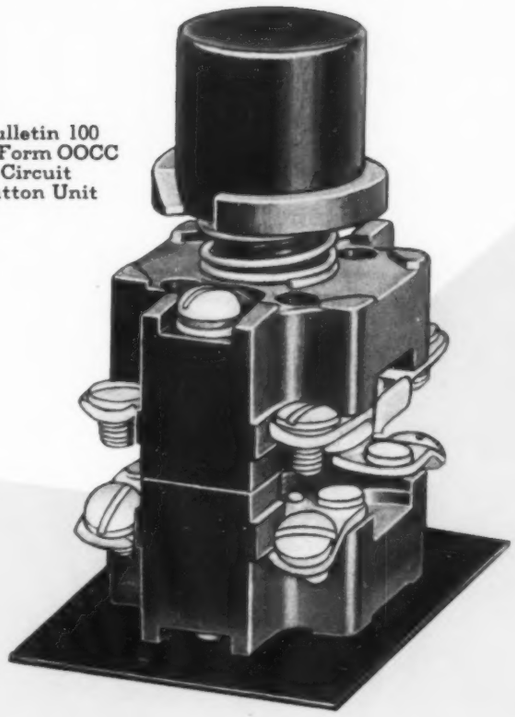
Besides these outstanding properties CHINALAK offers:

1. Oilproofness
2. Waterproofness
3. Acid and alkali resistance
4. Flexibility
5. High dielectric strength

If you are not using CHINALAK now, why not learn more about how it is providing trouble free insulation of electrical equipment in the plants of some of America's leading steel producers. Your request for information will not entail any obligation whatsoever.

Dolph's
JOHN C. DOLPH COMPANY
Insulating Varnish Specialists
166A EMMETT ST. NEWARK, N. J.

It Never Gets "SLAP HAPPY"



"3C" Bulletin 100
Type "D" Form OOCC
Four-Circuit
Push Button Unit

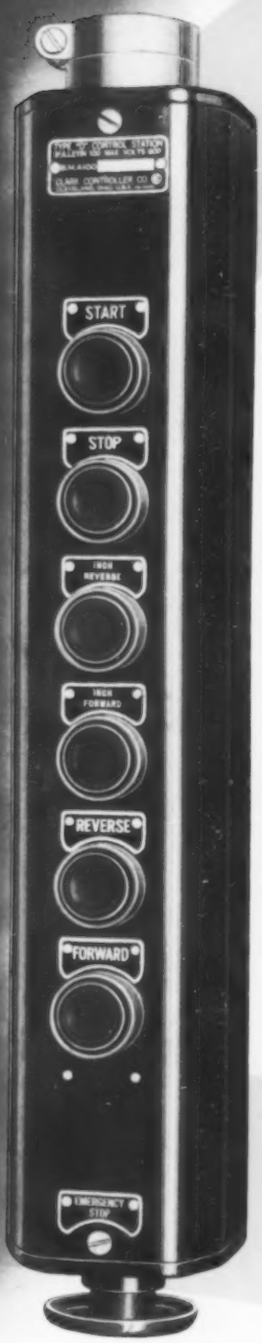
THIS sturdy Push Button unit is ruggedly built to stand frequent operation. Silver-to-Silver Button Type Double Break Contacts insure long life, while all insulating parts are Bakelite in heavy section to deliver service.

In operations such as on Power Presses, "3C" Pendant Push Buttons provide a double element of safety, as the station is suspended so that the operator's hands are kept out of the danger zone and the "EMERGENCY-STOP" button is easily located at the bottom of the case.

This Palm-Operated Button can be slapped with the open hand, requiring no searching to locate, thus providing prompt action.

To insure plenty of room for bringing in all wires through the top knockouts, the space normally occupied by one unit is left at the top of the enclosure.

Open View
"3C" Bulletin 100
Pendant
Push Button
Station



Closed View
"3C" Bulletin 100
Pendant
Push Button
Station

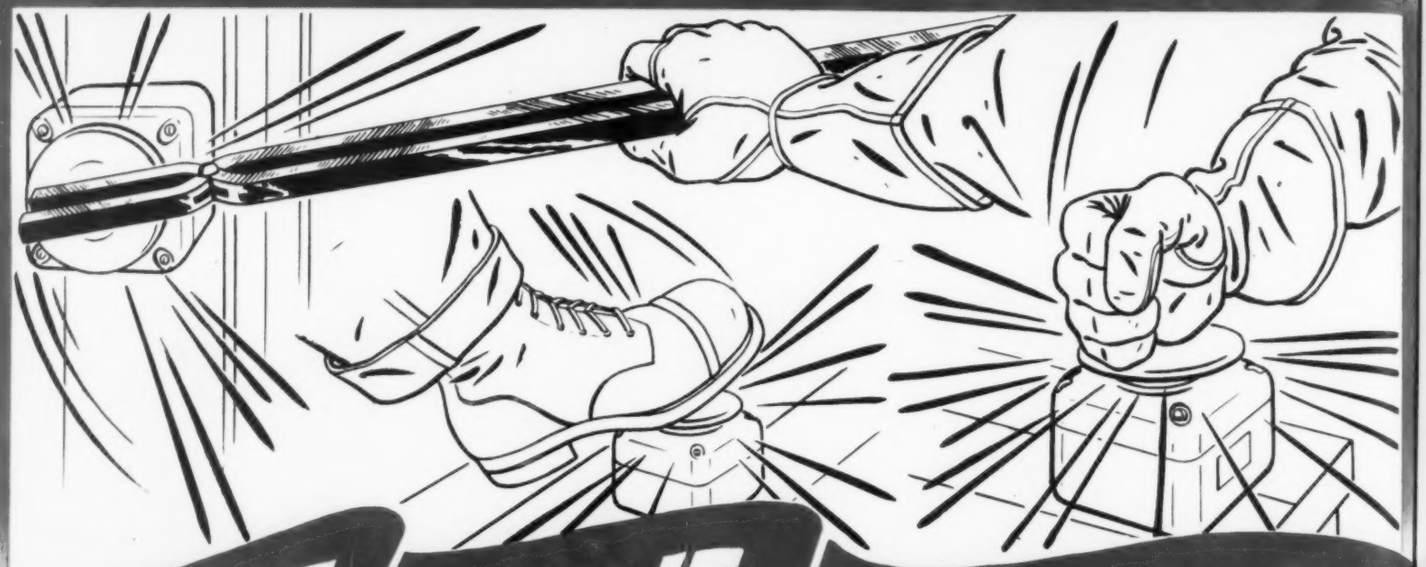
These Pendant Stations can be supplied in from 1 to 6 units on the face of the enclosure, and the Palm-Operated Mushroom Head on the bottom. The Clamp Collar at the top adds $1\frac{1}{4}$" and the Mushroom Head adds $1\frac{3}{16}$", or a total of $2\frac{5}{16}$", as shown on the dimensions below.

No. of Units	Encl. Length	Add for Collar & M.H.	Total
1	$8\frac{1}{8}$	$2\frac{5}{16}$	$10\frac{7}{16}$
2	10	$2\frac{5}{16}$	$12\frac{5}{16}$
3	$11\frac{7}{8}$	$2\frac{5}{16}$	$14\frac{3}{16}$
4	$13\frac{3}{4}$	$2\frac{5}{16}$	$16\frac{1}{16}$
5	$15\frac{5}{8}$	$2\frac{5}{16}$	$17\frac{15}{16}$
6	$17\frac{1}{2}$	$2\frac{5}{16}$	$19\frac{13}{16}$

OFFICES IN PRINCIPAL CITIES

THE CLARK CONTROLLER CO.

1146 EAST 152ND ST. CLEVELAND, OHIO



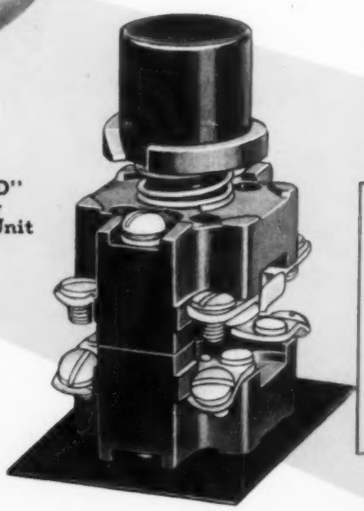
HIT IT · KICK IT · PUNCH IT

It still does the work

These units feature silver-to-silver, button type Double Break Contacts, large electrical clearances, Bakelite insulating parts, push button stop independent of contacts, and all parts removable and replaceable with a screwdriver.

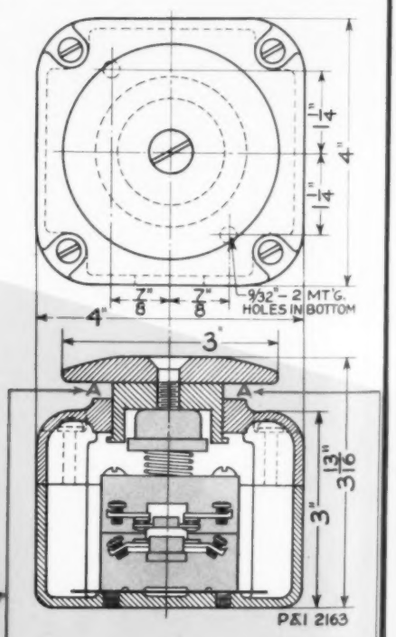
For installations where hard service is encountered, the ROUGHNECK will be entirely satisfactory.

The Real "Roughneck" of the "3C" Push Button Family



"3C" Type "D" Heavy Duty Push Button Unit

The ROUGHNECK is low and squatty—built close to the ground—and with plenty of "bearing area" so that rough and ready usage doesn't rock him on his base. If you miss that smoothly, flatly curved disc with blows, kicks, or punches, the impact slides smoothly off the shoulders. Observe in the cross-section the husky neck supporting the disc. That's strength to "grin and bear it" under gruelling punishment.



Impact shock absorbed here, instead of on insulation material, which is indicated in red shaded portion of drawing.

CONTINUE TO ROLL WITH CLARK CONTROL

THE CLARK CONTROLLER CO.

1146 EAST 152ND ST. CLEVELAND, OHIO

Where Others Fail
TRY DELTABESTON

Hot as the Hinges . . . . .!

A fiery steel ingot swings down into the soaking pit, and waves of blistering, scorching heat sweep over the jaws of the crane—*and also over the control and power cable!*

Ordinary cable can't take such heat. But General Electric Deltabeston can take it day after day, year 'round, without failure. That's why iron and steel engineers choose Deltabeston for mill operations where searing heat would soon tear apart ordinary cables.

Perhaps you'd like to know more about Deltabeston and its ability to absorb tough punishment. Call your nearest G-E Merchandise Distributor or a branch of the Graybar Electric Company, or write to Section Y-2314, Appliance and Merchandise Department, General Electric Company, Bridgeport, Conn.

GENERAL ELECTRIC

ITEMS OF INTEREST

Walter F. Munford, assistant manager of operations, Pittsburgh district, American Steel and Wire Company, has been appointed manager of operations, Worcester, Massachusetts, district, for the company, a subsidiary of United States Steel Corporation.

Mr. Munford was born in Worcester and was educated in its public schools and at Worcester Polytechnical Institute and the Massachusetts Institute of Technology.

After leaving school, Mr. Munford became a helper in the open hearth department of the Wire company at Worcester. He held other positions before being made superintendent of the open hearth in 1927. In 1930 he was transferred to Cleveland and was named superintendent of the open hearth at the company's Newburgh Works in that city. Three years later, when that division was dismantled, he was transferred to the National Tube Company at Lorain, Ohio, as assistant superintendent of the Steel Works. In 1934 he returned to American Steel and Wire as assistant superintendent at Cuyahoga Works, Cleveland, and in 1937 was named superintendent of that plant. After a period as assistant to the vice-president of the company in 1939 he was made assistant manager of operations, Pittsburgh district, in December of that year.

John L. Young, manager of machinery sales, United Engineering and Foundry Company, Pittsburgh, has been placed in charge as project manager of a new division of the company for construction of an aluminum sheet rolling mill plant in the West under a contract with Defense Plant Corporation, Washington. **William Hagel,** formerly assistant to sales manager, has been promoted to assistant sales manager and has assumed the duties of Mr. Young during the period of construction of the aluminum plant.

JOHN L. YOUNG

. . . to supervise construction of new aluminum mills.

Other personnel of the new construction organization includes: K. C. Gardner, Jr., and H. O. Shepard, project engineers; W. R. Hodder, structural engineer; H. F. Voigt, specification engineer; A. A. Straub, chief clerk; N. J. Crain, general purchasing agent; B. D. McMillen, Jr., project purchasing agent (Pittsburgh); Field organization will be headed by: T. A. Frazier, project superintendent, G. C. Schutte, project purchasing agent; H. W. Fitzgerald, plant engineer.

E. K. Waldschmidt has been appointed special representative on shell steel allocations for WPB. He had been associated with Jones and Laughlin Steel Corporation, Pittsburgh, for many years, serving in various capacities in metallurgical and sales work. He recently was promoted from the metallurgical department to cold finished sales of the corporation.

Ralph C. Edgar has been named manager of industrial relations, Allegheny Ludlum Steel Corporation, Pittsburgh. Mr. Edgar has been engaged in public relations work a number of years, having served as publicity representative of Westinghouse Electric and Manufacturing Company and later for other industrial and commercial clients. Since 1936 he has worked for the advancement of flood control for western Pennsylvania, in the capacity of secretary, Tri-State Authority, and secretary, United States Flood Control Federation.

E. C. Bolton, associated with Cutler-Hammer, Inc., Milwaukee, 19 years, has been appointed manager of the Cincinnati district sales office. The past 16 years he has been located at Chicago.

H. V. Lauer, superintendent of the Joliet coke plant Carnegie-Illinois Steel Corporation, since September 1939, has been appointed assistant division superintendent, Gary works coke plant and blast furnaces, including Joliet works.

H. H. Jones, superintendent of maintenance at the Gary works coke plant since March 1940, has been made superintendent of the Joliet coke plant, succeeding H. V. Lauer.

C. V. Lauer, who has been second assistant superintendent of Gary works blast furnaces since May 1936, receives the post of first assistant superintendent of blast furnaces, succeeding **A. W. Vincent,** retired.

G. P. Burks, chief chemist of Gary works since September 1937, succeeds C. V. Lauer as second assistant superintendent of blast furnaces.

E. C. Kennedy, who has been assistant to superintendent of the Gary works coke plant since February 1941, receives the post of assistant superintendent of this plant.

O. W. Baldwin, assistant chief chemist of Gary

works since June 1940, succeeds G. P. Burks as chief chemist.

G. W. Rimmer succeeds O. W. Baldwin as assistant chief chemist, Gary works. Mr. Rimmer has been general foreman, Gary works chemical laboratory, since September 1939.

WANTED — Mechanical and Electrical Engineers on steel plant construction. Location, Cleveland. Salary. Give full particulars and salary in first letter. Apply Construction Engineer, American Steel and Wire Company, Rockefeller Building, Cleveland, Ohio.

Obituaries

Chester W. Phillips, who was superintendent of maintenance at the Cleveland steel plants of Republic Steel Corporation, died suddenly in the Buffalo General Hospital on March 26.

Mr. Phillips, who was born in Pawtucket, Rhode Island, March 24, 1888, resided in Warren, Ohio, for 31 years. In 1921 he joined the Trumbull Steel Company in Warren, a predecessor company of Republic. In 1937 he was transferred to the Cleveland District of Republic as superintendent of maintenance.

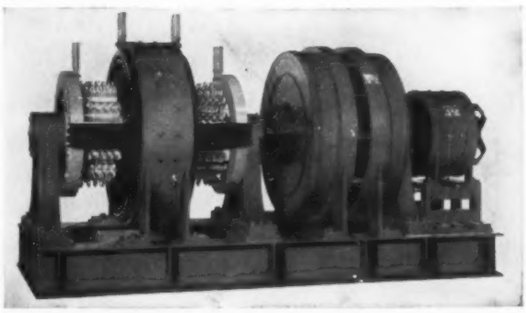
John E. "Pete" Daily, Chicago district manager of operations for the Youngstown Sheet and Tube Company, died recently in Chicago, Illinois, after illness of about a month. Born in Terre Haute, Indiana, Mr. Daily had been associated with the steel industry since 1905, following his graduation from Rose Polytechnic Institute in Terre Haute.

His first employment was with the Carnegie-Illinois Steel Corporation as a construction engineer. Later he was employed by the Brier Hill Steel Company, the Algoma Steel Company, the Sharon Steel Hoop Company, the United Alloy Corporation, the Timken Steel and Tube Company, and the Wheeling Steel Corporation.

Mr. Daily went to the Indiana Harbor Plant of Youngstown Sheet and Tube Company in 1934 as general superintendent of steel and coke plants, and about a year later was promoted to the position he held at the time of his death.

Increase Production—Improve Quality

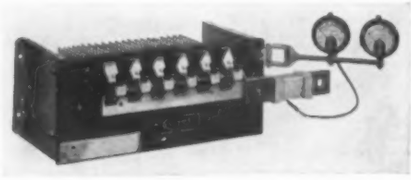
WITH THESE QUALITY - MADE COLUMBIA PRODUCTS



In these days of speed, speed, speed, you'll want to know the facts about Columbia Low Voltage Generators, Plating Tank Rheostats and Reversing Switches. For more than 15 years these Columbia products have been meeting the production and quality demands of the plating industry and, of relatively equal importance, we have them available now for prompt shipment.

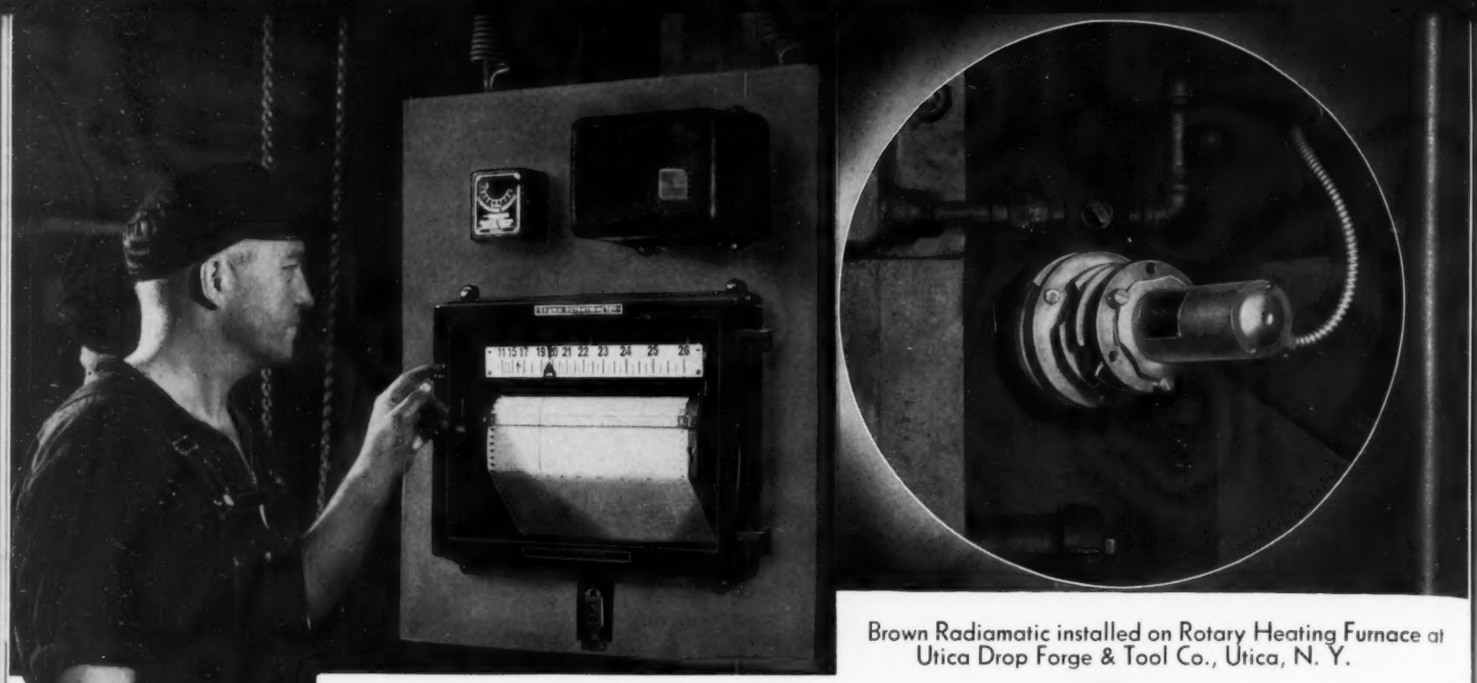
Write us your needs and we will send you complete information immediately.

Columbia Low Voltage Generators are built in sizes of 100 to 20,000 amperes, 6 to 60 volts. They are available for electroplating service in sizes of 6 to 20 volts, 500 to 20,000 amperes; for anodic treatment of aluminum in sizes of 30, 40, 50 and 60 volts, 500 to 5,000 amperes.
Columbia Reversing Switches are of the double pole, double throw type for use as reversing switches or series parallel switches on circuits up to 15 volts, 200 to 2,000 amperes.
Columbia Rheostat sizes range from 15 to 5,000 amperes and with a 3 to 6 volt drop.



COLUMBIA ELECTRIC MFG. CO., 4512 Hamilton Ave., Cleveland, Ohio

LOW VOLTAGE GENERATORS — COLUMBIA — PLATING TANK RHEOSTATS — REVERSING SWITCHES



Brown Radiamatic installed on Rotary Heating Furnace at Utica Drop Forge & Tool Co., Utica, N. Y.

What Users Like about BROWN RADIAMATIC PYROMETERS

1. Convenient to operate and universal in application for the measurement and control of temperatures.
2. Built to withstand severe industrial vibration, designed for continuous operation and long life service.
3. Completely self-contained. Built-in compensator — compensates for ambient temperature changes up to 250° F.
4. Can be sighted on hot objects, moving or still. Continuously measures and controls the temperature of furnace or work.
5. Measures and records temperatures beyond the range of conventional thermocouples.
6. Extremely responsive — will not overshoot.
7. Interchangeable accessories for all industrial applications.
8. Accuracy is unaffected by dust, dirt, fumes, or corrosive atmospheres.
9. Neat in appearance — Easily installed — The Brown Radiamatic consists essentially of a heat-resisting lens, a compensator and a thermopile. The heat radiated from the hot object falls on the lens and is focused on the thermopile which generates an E.M.F. proportional to the true temperature.
10. Users of Brown Radiamatics have found temperature measurement by the radiation principle highly accurate and dependable. Substantial saving in fuel and operator's time has been proven — Spoilage is reduced and better quality attained. Speed up production by using Brown Radiamatic Pyrometers.

Write for information.

BROWN POTENTIOMETER CONTROLLERS

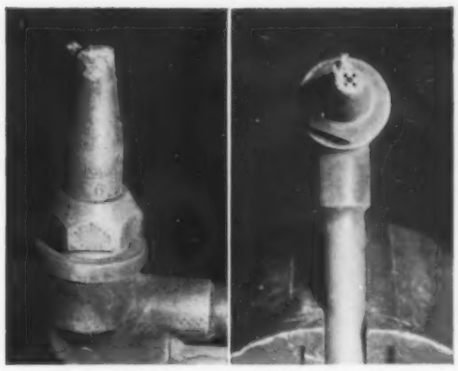
THE BROWN INSTRUMENT COMPANY, 4464 WAYNE AVENUE, PHILADELPHIA, PENNSYLVANIA

DIVISION OF MINNEAPOLIS-HONEYWELL REGULATOR CO.

MINNEAPOLIS, MINNESOTA, AND 119 PETER STREET, TORONTO, CANADA

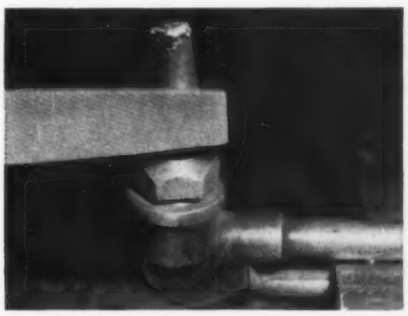
WADSWORTH ROAD, PERIVALE, MIDDLESEX, ENGLAND — NYBROKAJEN 7, STOCKHOLM, SWEDEN

When Oxy-Acetylene Cutting Nozzles Look Like This..*Clean Them*

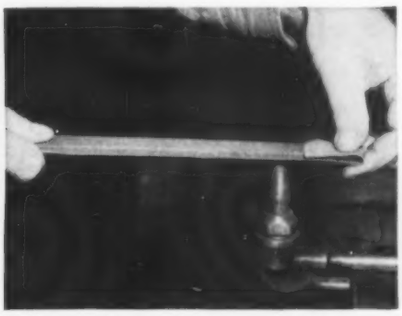


Good results in oxy-acetylene cutting depend upon an accurate flame adjustment, and this requires clean nozzles. In addition to making possible more accurate cutting, correct maintenance will make your nozzles last longer.

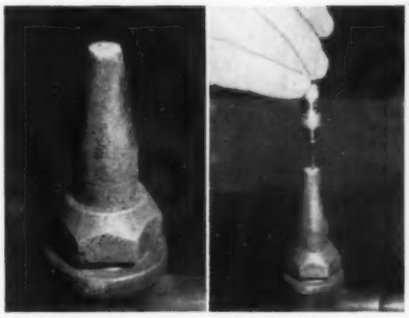
Here's how to do it...



1. Clamp the blowpipe in a vise, inserting a soft material in the jaws to protect the tubes. Knock away loose slag with a file.

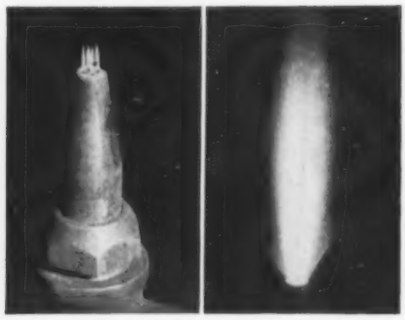


2. Wrap a piece of fine emery cloth around the file and clean the nozzle end so that it is smooth and square.



3. Next take a drill *two sizes smaller* than the size recommended in the instruction booklet furnished with the blowpipe. Work it up and down in the gas orifices. *Do not twist the drill.* Then, using the recommended size drill, repeat this operation.

4. If you do not have the correct sizes of drills, use a piece of copper, or soft brass, wire. A satisfactory substitute drill can be improvised by doubling the wire from a Prest-O-Lite cylinder tag, and then twisting it in a vise until it is tight.



5. After cleaning the nozzle, test the flames by lighting the blowpipe. All of the preheat flames should be the same shape and length, and the cutting oxygen jet should be straight and symmetrical, as shown in the illustrations above.

Instruction Books Available

• You may obtain without charge duplicate copies of the instruction booklets furnished with blowpipes supplied by Linde. Also available is "Precautions and Safe Practices." Write for the copies you need.

THE LINDE AIR PRODUCTS COMPANY

Unit of Union Carbide and Carbon Corporation

UCC

General Office: 30 East 42nd Street, New York, N.Y.

Offices in Other Principal Cities

In Canada: Dominion Oxygen Company, Limited, Toronto

You Can Obtain Copies of this Advertisement For Distribution in Your Shop . . . or to Post on Your Bulletin Boards . . . Upon Request.

LINDE OXYGEN · PREST-O-LITE ACETYLENE · UNION CARBIDE
OXWELD, PREST-O-WELD, PUROX APPARATUS · OXWELD SUPPLIES

The words "Linde," "Prest-O-Lite," "Union," "Oxweld," "Purox," and "Prest-O-Weld" are trade-marks of Units of Union Carbide and Carbon Corporation.

Protect
YOUR FIRST LINE OF DEFENSE *with* HOLOPHANE REFRACTORS

FENCE LIGHTING is an indispensable factor in any effective system of plant protection. Holophane Refractors, designed for this purpose, have been installed in over 350 major armament plants in recent months.

WHY REFRACTORS? . . . They control the light vertically *and* horizontally, shaping the light to the specific job needs . . . Made of heavy prismatic glass, they are durable and impervious to the effects of time and weather. Their high output efficiency and controlled distribution permit wider spacings to reduce operating and maintenance costs.

Three types of refractors are most widely used for protective lighting; (1) 2-Way asymmetric, for fence lighting; (2) C-Way asymmetric, for roadways; (3) Symmetrical, for yards and gates.

WRITE FOR COMPREHENSIVE BOOK of specifications and installation methods for protective lighting, sent without cost or obligation.

Complete units, equipped with Holophane Refractors, are made by

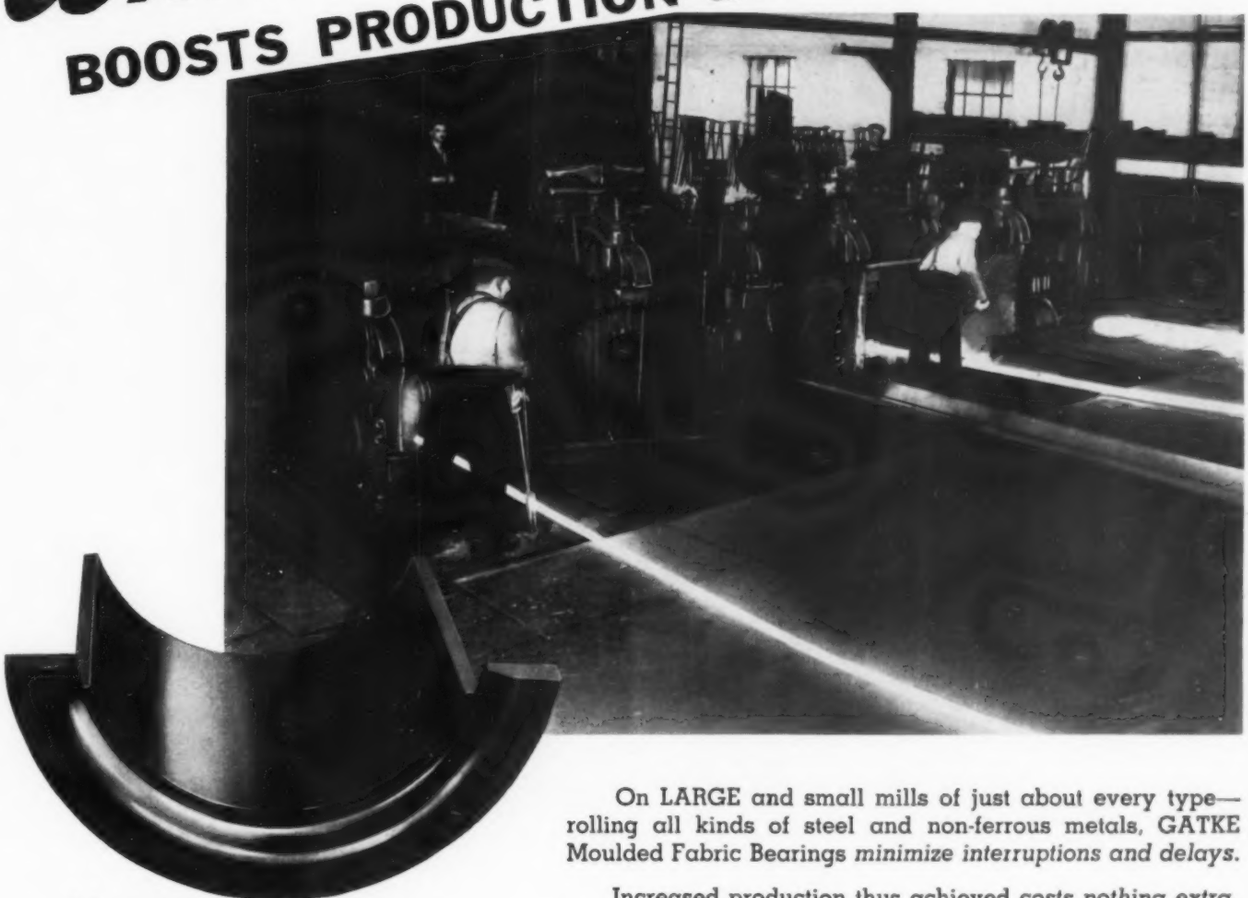
GENERAL ELECTRIC COMPANY Schenectady, N. Y.
PHILADELPHIA ELEC. & MFG. CO. Philadelphia, Pa.
LINE MATERIAL COMPANY Milwaukee, Wis.
WESTINGHOUSE ELEC. & MFG. CO. Cleveland, Ohio

HOLOPHANE CO., INC. *Lighting Authorities Since 1898* **342 MADISON AVENUE, NEW YORK**
HOLOPHANE CO., LTD., 385 YONGE STREET, TORONTO, CAN.

YOUR PLANT IS SAFER WITH HOLOPHANE REFRACTORS

Continuous Operation

BOOSTS PRODUCTION at NO EXTRA COST



Advantages that facilitate maximum mill output—

- **Lowest Friction**
- **Great resistance to shock loads**
- **Long wear beyond belief**
- **Elimination of hot necks and neck scoring**
- **Accurate maintenance of gauge**

On LARGE and small mills of just about every type—rolling all kinds of steel and non-ferrous metals, GATKE Moulded Fabric Bearings *minimize interruptions and delays.*

Increased production thus achieved *costs nothing extra.* In fact, additional economies effected by GATKE Bearings—*reduced maintenance expense—tremendous power savings—elimination of grease and greasing costs*—make the use of conventional bearings downright wasteful.

The *sooner* you start using GATKE Bearings, the *sooner* you will *put an end to needless grief* and *start making plenty of extra profit* for your company.

Write for literature.

Other **GATKE PRODUCTS**

Brake Lining
Clutch Facings
Friction Blocks
Silent Gears
Pump Valves
Piston Rings
Sheet Packings

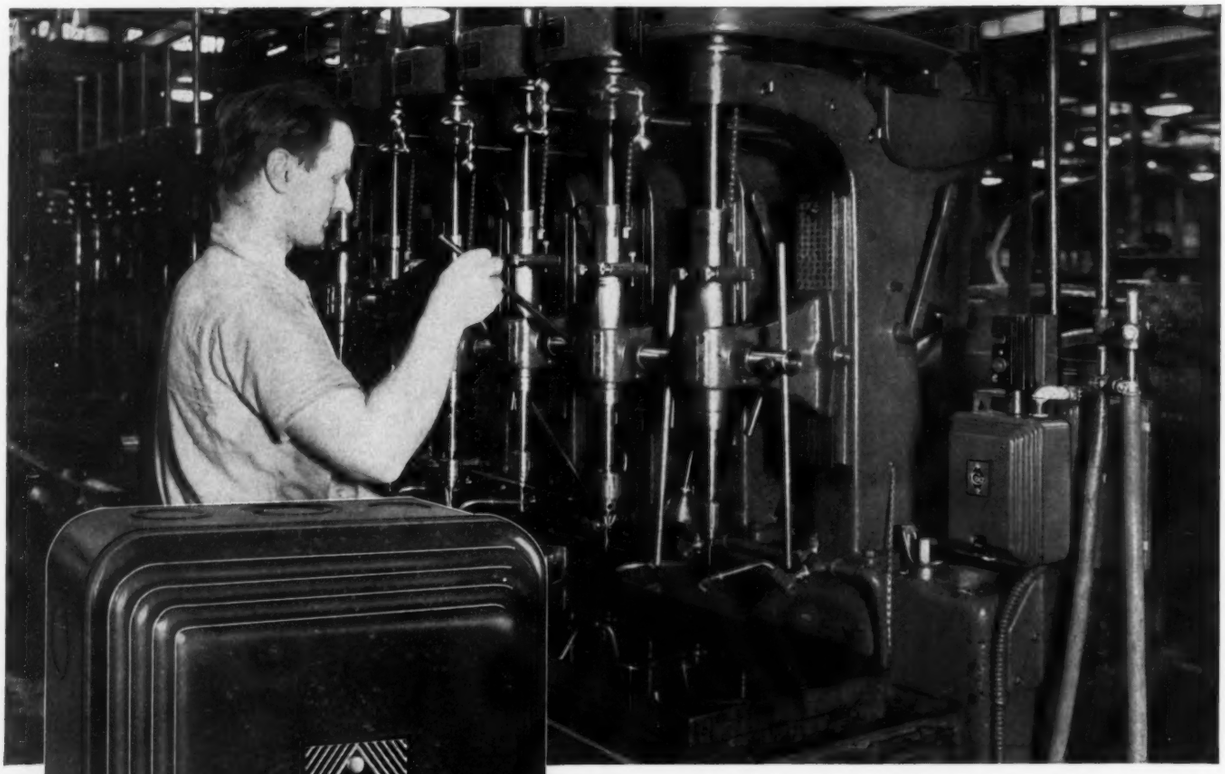
GATKE CORPORATION • 228 N. LaSalle St., CHICAGO

Gatke MOULDED FABRIC Bearings

For Roll Necks, Universal Couplings, Spindle Carriers, Table Rolls, Cranes, Acid Resisting Service, and Other Tough Jobs.

Controlled by a . . .

COLT MAGNETIC STARTER



Illustrated is a Colt Magnetic Starter and a Colt Push Button Station.

Designed and built to help maintain today's 24-hour industrial activity . . .

- Straight line vertical operation.
- 3-point ball bearing armature guides.
- Double break pure silver contacts.
- Non-carbonizing molded contact block.
- Thermal overload relays with instant choice of hand or automatic resetting.
- Available in many forms—with local, remote, and transfer switch control.

COLT'S PATENT FIRE ARMS MFG. COMPANY
ELECTRICAL DIVISION HARTFORD, CONN.
106th YEAR OF PRECISION MANUFACTURING

We are making a real all-out effort

IT is hardly necessary for us to tell our customers that it is becoming increasingly difficult to fill their orders as promptly as we should wish. The effects of the complex influences at work in the war production program are now well understood. Our products and the materials from which they are manufactured are on the critical lists, and are subject to priority control with its unavoidable delays and disappointments.

You can be assured however that our entire organization is making a supreme effort to meet the difficulties as they arise, exerting every facility to meet the needs of your industry which is so vital to the war program. We want to stress the point that your orders today are as carefully handled as they were during those days of recent memory when our big problem was not how to meet the demand but how to keep our men employed and best occupy plant facilities.

WORTHINGTON EQUIPMENT *for* STEEL PLANTS

FOR CONTINUOUS STRIP MILLS
Complete descaling systems from pump to spray nozzle.

FOR DRY BLAST SYSTEMS
Dehumidification equipment . . . including centrifugal and reciprocating refrigeration compressors.

FOR BY-PRODUCT COKE PLANTS
General hydraulic service and water supply . . . pumps of every size and type, centrifugal, steam and power.

FOR THE POWER PLANT
Steam turbines, steam condensers, boiler feed pumps, feedwater heaters, air ejectors, vacuum pumps, water softeners and pressure filters.

FOR GENERAL AND LOCAL COMPRESSED AIR SUPPLY
Compressors of every type from the smallest to the largest . . . for every type of drive.

WORTHINGTON

MI2-11

WORTHINGTON PUMP & MACHINERY CORPORATION • GENERAL OFFICES: HARRISON, N. J.

Cut the Load in TWO PARTS...

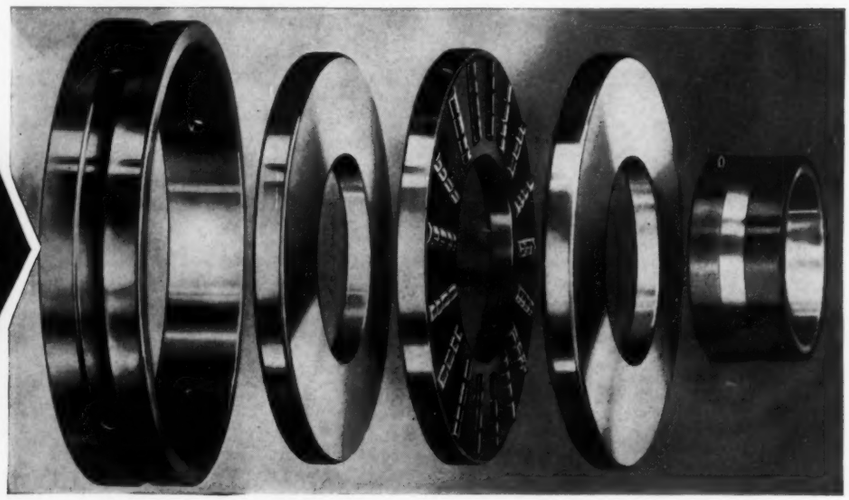
Stop Overworking Your Bearings

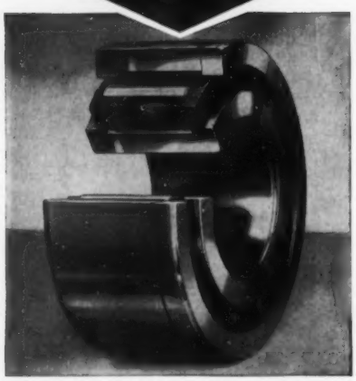
during the Non-Stop, 168 Hour Week

It's a common mistake to think of thrust loads as part of the main load and to lump them all on combination radial-and-thrust bearings. But it's tough on bearings, tough on power sources, tough on lubrication and maintenance men, and it *shortens bearing life*—also cuts the load that can be carried in given dimensional limits.

ALL THRUST
Loads carried at RIGHT ANGLES to Roller Surface

ALL RADIAL
Loads carried at RIGHT ANGLES to Roller Surface





Top—*Type SDT Thrust Bearing—double-acting.* Above—*Type MN Double Width Radial Bearing.*

SPLIT THE LOAD and SAVE THE BEARING

The Rollway practice of splitting the load into two simple components of *pure radial* and *pure thrust* greatly lengthens bearing life. It increases the speed at which maximum bearing life is possible, improves the shock-absorbing capacity of the bearings, reduces starting torque.

Rollway specializes in solid cylindrical rollers exclusively. That means greater mass per unit of load and uniform cross-section of rolling element. It means that all loads are carried at right angles to the roller axis—there's no pinching or wedging action.

Engineered to Provide Standard Sizes for Most Applications

Engineered for thousands of applications in various industries, Rollway's wide range of series and types provides standard metric dimensions and tolerances for practically every design. Hence you insure easier replacement or change-over and lower cost. *Send us your drawings—particularly your conversions—for free engineering analysis and bearing recommendations.*

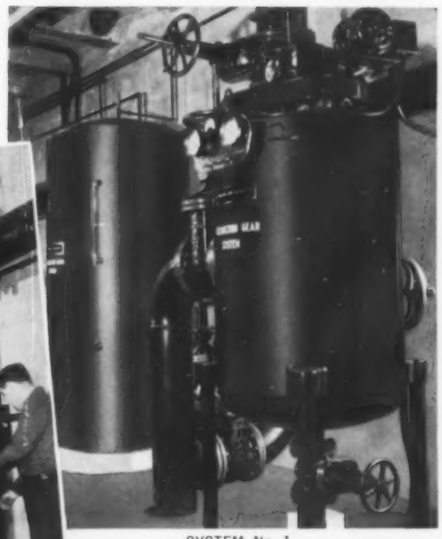
ROLLWAY BEARING COMPANY, INC., SYRACUSE, N. Y.

BUILDING HEAVY-DUTY BEARINGS SINCE 1908 **BEARINGS**

Largest, Latest-Design Hot Strip Mill Uses

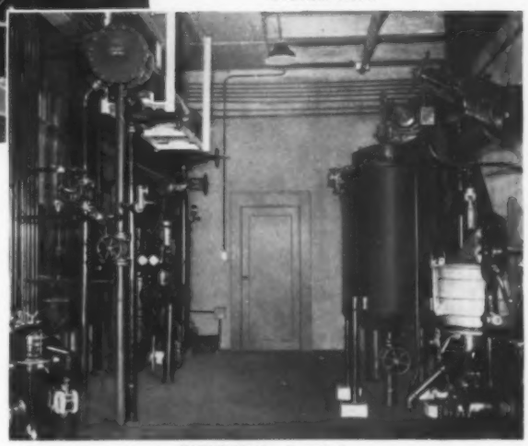
CUNO CONTINUOUS PROTECTION

on New Style Lubrication



SYSTEM No. 1

SYSTEM No. 2



SYSTEMS No. 3 and 4

The lubricating system of the 80" hot strip mill at the Irvin Works of Carnegie-Illinois Steel Corp., radically departs from old-style methods. Four separate recirculating systems lubricate the gear drives (gears and bearings), the pinion stand gears and bearings, the oil type back-up roll bearings, and the bearings of large mill drive motors and generator sets.

All four systems have the benefit of protection by Cuno Auto-Klean Filters — guarding continuously against solids larger than .008" which must be kept out of bearings and gears.

NO DELAYS FOR FLUID CLEANING . . . FULL FLOW POSITIVELY CLEANED AT ALL TIMES

The full flow of oil passes through the Cuno Filters, and a partial flow from the filters is diverted through centrifuges for clarification. The Cuno Auto-Klean is cleanable while operating — manually or automatically. The metal discs which do the filtering are permanent.

Consider Cuno for your fluid-cleaning — you get positive, automatic and continuous cleaning without the expense of duplex installations and without the nuisance and expense of replaceable filter elements. For further information and new booklet "Quick Facts," write 904 South Vine St., Meriden, Conn.

OPERATING DATA

System	Filter Capacity	Viscosity at 100° F.	Pressure Drop (lbs. per sq. in.)
No. 1—Gear Reducers	435 g.p.m.	1750 SSU	3-4 lbs.
No. 2—Pinion Stands	580 g.p.m.	2400 SSU	3 lbs.
No. 3*—Oil Bearings	400 g.p.m.	2400 SSU	5 lbs.
No. 4—Motor Bearings	100 g.p.m.	320 SSU	3 lbs.

*On system No. 3, there are 22 other Cuno Filters placed one on each side of the roll housings to protect expensive back-up roll bearings.

KEEP FLOW ON "GO" WITH

CUNO

NO STOPS FOR CLEANING FLUID . . .
NO STOPS FOR CLEANING FILTER

WRITE FOR FREE BOOKLET, "QUICK FACTS".

CUNO ENGINEERING CORPORATION
MERIDEN, CONNECTICUT

ROWAN

Oil Immersed

MOTOR CONTROL

OK

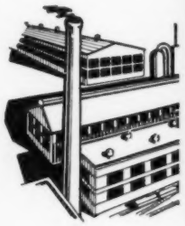
BY USERS EVERYWHERE

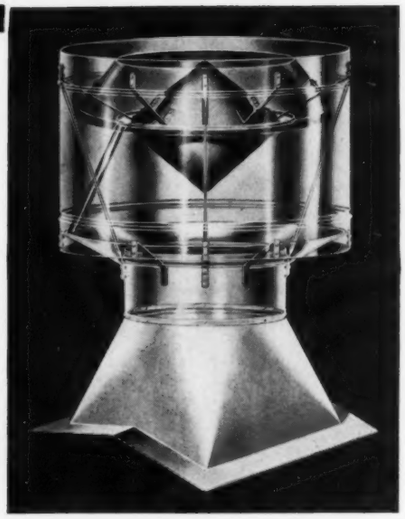
ROWAN CONTROL

THE ROWAN CONTROLLER CO., BALTIMORE, MD.

Free Flow

Gravity





BURT

VENTILATORS

Improve Morale
Increase Efficiency

Make your workers comfortable with proper ventilation and you make them both happier and more efficient. The steel plant equipped with Burt Ventilators will have better working conditions and improved, steadier production.

Burt makes three types adapted for steel mill installations—Free-Flow Fan, Monovent Continuous Ridge Ventilator, and Free-Flow Gravity, illustrated above. You can depend on all for high efficiency and long dependable service.

Write for detailed data and job references.

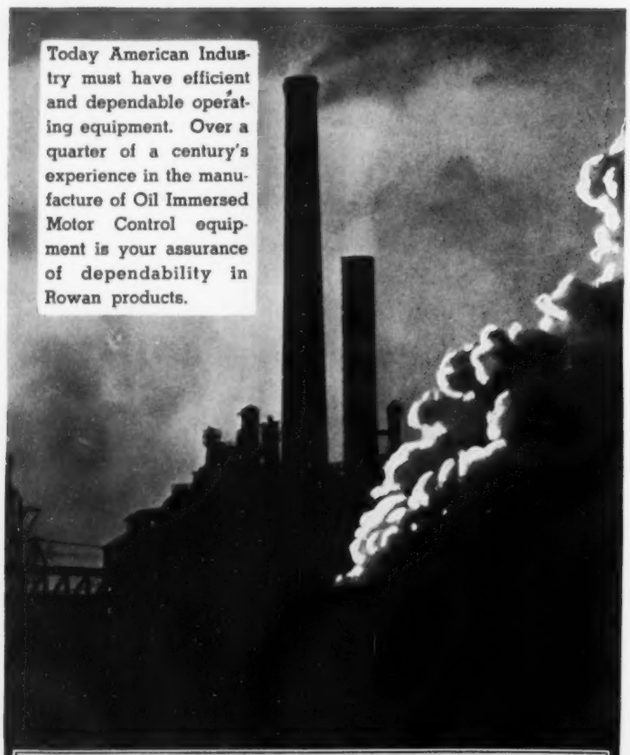
THE BURT MFG. CO.

ROOF VENTILATORS • OIL FILTERS
EXHAUST HEADS

850 SOUTH HIGH STREET AKRON, OHIO

SEND FOR CATALOGS

Burt Engineers are glad to help on plans



Today American Industry must have efficient and dependable operating equipment. Over a quarter of a century's experience in the manufacture of Oil Immersed Motor Control equipment is your assurance of dependability in Rowan products.

ROWAN CONTROL

THE ROWAN CONTROLLER CO., BALTIMORE, MD.

OHIO
Maximum Lift MAGNETS

A standard 65" Ohio Magnet
Lifting 5200 lbs. of Pig Iron

Standard round general purpose Ohio magnets are built in sizes from 12" to 65" in diameter.

Average lifting capacity for pig iron or scrap ranges from 200 lbs. to 6200 lbs.

Depending upon the amount of material to be handled, the largest suitable magnet will do it most economically.

Labor cost per lift is the same whether the lift be 200 lbs. or 6200 lbs.

OHIO reliable MAGNETS

THE OHIO ELECTRIC MFG. COMPANY

5907 Maurice Ave. Cleveland, Ohio

Take Good Care of Ball and Roller Bearings

Day by day it's harder to get replacements. Long life and dependable service that guarantee full time production from all your machines, demand proper lubrication of ball and roller bearings.

NON-FLUID OIL *is recommended* (and used) by practically all makers of ball and roller bearings. Their tests proved it insures long life and trouble-free operation. NON-FLUID OIL saves money on lubrication too — outlasts grease many times over. Don't take chances with products not approved by bearing engineers.

Used successfully in leading iron and steel mills. Send for testing sample today — prepaid — NO CHARGE.

•

New York & New Jersey Lubricant Co.

Main Office: 292 Madison Ave., New York, N. Y.

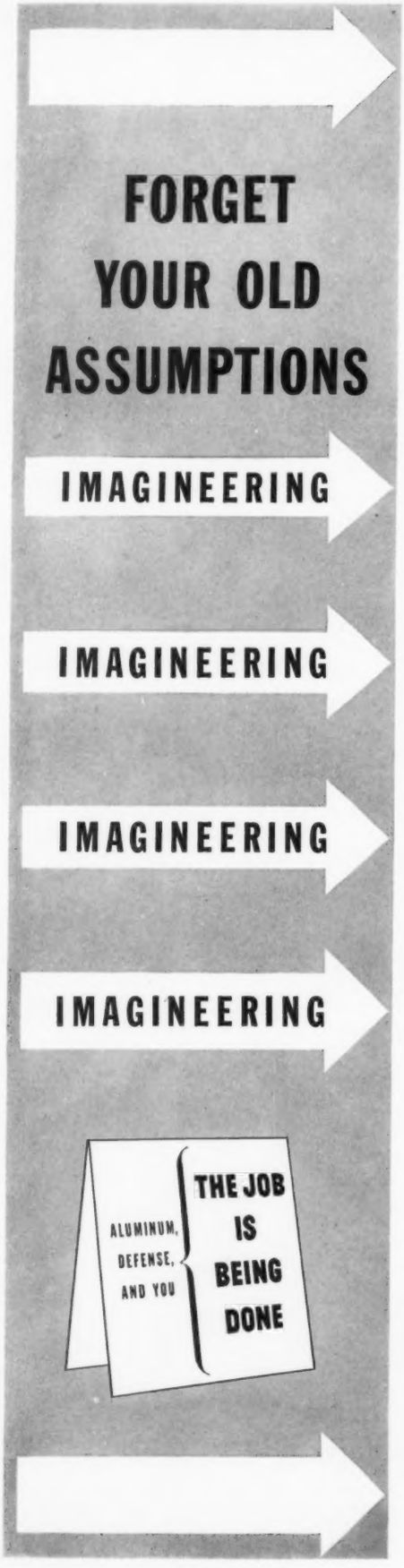
WAREHOUSES:

Chicago, Ill. — Atlanta, Ga.
St. Louis, Mo. — Detroit, Mich.
Providence, R. I. — Greenville, S. C.

TRADE MARK REGISTERED
NON-FLUID OIL
IN U.S. PAT OFFICE & FOREIGN COUNTRIES

MODERN STEEL MILL LUBRICANT

Better Lubrication at Less Cost per Month



IN THESE DAYS an advertisement is no place either for hosannas or sermons about production. Every man knows how well he is doing the job that is before him. Deeds, not words, are the measure.

BUT WORDS CAN BECKON beyond the realms of immediate duty.

IMAGINEERING is such a word. We coined it to make the needs of the future a reality, here and now. It is a way of describing what a man can do about the day when. . .

HOW DO YOU DO IT? You let your imagination soar and then engineer it down to earth. You think about the things you used to make, and decide that if you don't find out some way to make them immeasurably better you may never be asked by your customers to make them again.

YOU FORGET YOUR OLD ASSUMPTIONS. For instance, you may be one who used to assume that aluminum was too expensive. Even if you were right then (and you may not have been) the price trend of aluminum knocks those assumptions into a cocked hat.

WERE YOU ONE who used to assume that structures behaved exactly the way the theory said? Have you looked into the new answers the mammoth testing machine in the Aluminum Research Laboratory has found for that one?

DID YOUR OLD PRODUCT GROW like Topsy? More than one designer is Imagineering with this point of view: My product was in a groove. I couldn't get it out, because I didn't dare get too far away from last year's model. Now's my chance to start from scratch, and let tradition be hanged.

THAT IS THE KIND OF THINKING that will make jobs in the future. It is the kind we can help with: help with ideas and with know-how. Will you invite us?

Aluminum Company of America, 2128 Gulf Building, Pittsburgh, Pennsylvania.

ALCOA ALUMINUM

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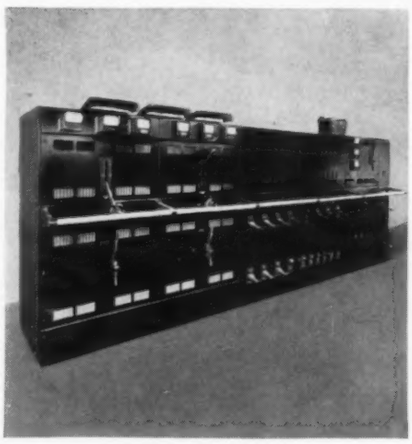
NORMA-HOFFMANN
MADE IN U.S.A.
NORMA-HOFFMANN
MADE IN U.S.A.
PLEDGED to all-out aid to America's fighting forces, NORMA-HOFFMANN is devoting all its resources and its 31-years' experience, to the production of PRECISION BEARINGS for the Army, Navy and Air Corps, and for manufacturers of armament and equipment.
NORMA-HOFFMANN BEARINGS CORPORATION, STAMFORD, CONN., U. S. A.
BALL, ROLLER AND THRUST BEARINGS • FOUNDED 1911

MUCH MORE FACTORY SPACE
for building
MUCH MORE I-T-E SWITCHGEAR



Only by thoughtful expansion has it been possible to provide facilities in keeping with the emergency demand for I-T-E air switchgear.

Thoughtful . . . in the vital sense that each unit of switchgear must retain, regardless of the quantities being produced, all the characteristics of a quality product. Doubling factory space within one year means doubling the tools, doubling the number of skilled hands and making all new elements work well together.

The space indicated by the large block in the photograph above is tooled and staffed like the I-T-E factory space represented by the blocks preceding. The new facilities have not mushroomed. They are of I-T-E character, and the switchgear they produce is their witness.

I-T-E

AIR SWITCHGEAR

IMMERSED IN AIR • ENCASED IN STEEL

Representatives in Principal Cities

CIRCUIT BREAKER CO., PHILADELPHIA, PA.

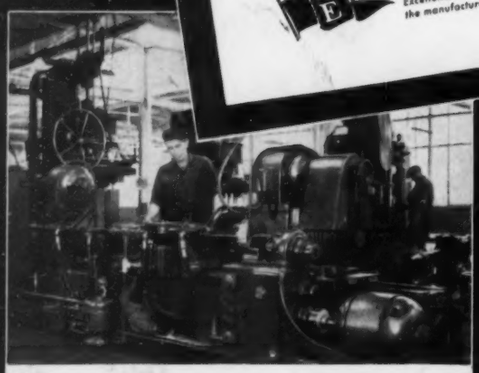
TODAY'S TOUGH JOBS CALL FOR TRI-CLAD MOTORS

REG. U.S. PAT. OFF.

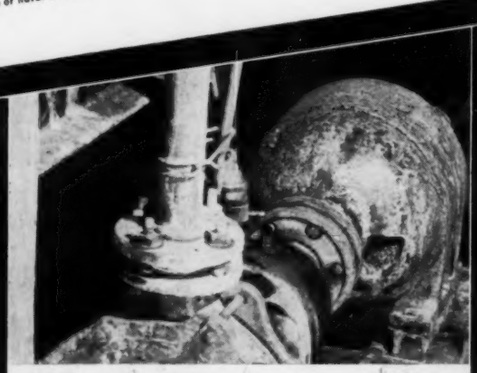
TODAY, you must be sure the motors you buy will give you 24-hour operation, even on the *tough* jobs. Here's where the Tri-Clad motor becomes a real asset. Its cast-iron frame and end shields are a safe-guard against accidental blows. The stator winding is protected against damage from oil, moisture, and heat shock. Improved bearings are enclosed in cast iron, protected against the entry of dust or dirt. Ask your G-E representative for details on types and sizes now available, or write General Electric Company, Schenectady, N. Y.

Now available up to 100 HP in standard, open construction

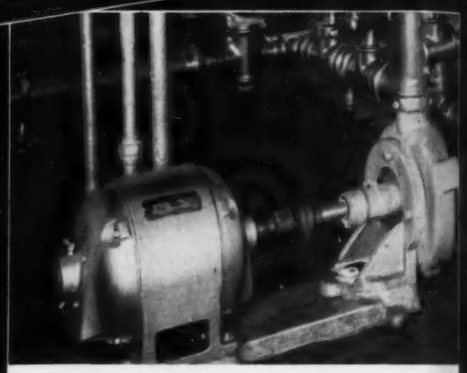
General Electric and its employees are proud of the Navy award of Excellence made to its Erie Works for the manufacture of naval ordnance.



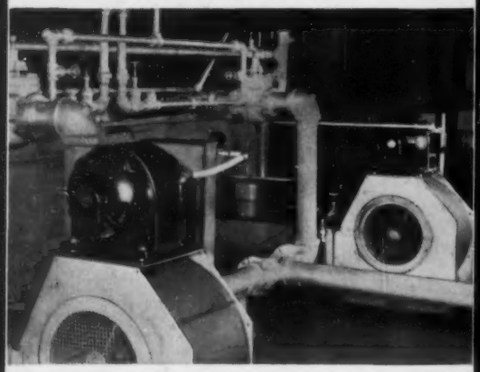
BIG JOB On machines vital to the war effort, Tri-Clad motors are well guarded by their cast-iron frames from metal chips or dripping coolants.



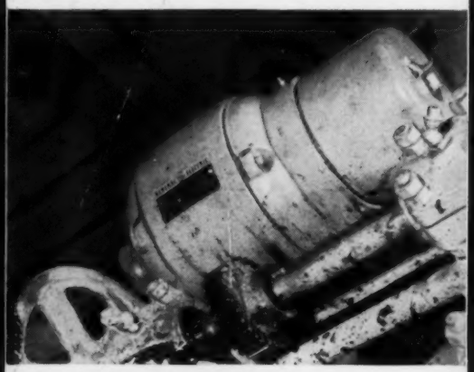
DIRTY JOB Note how dust and fumes have coated this Tri-Clad ball-bearing motor. This is service for which we might not recommend open motors, such as that shown, but we are glad to chalk up this instance of motor stamina under severe operating conditions.



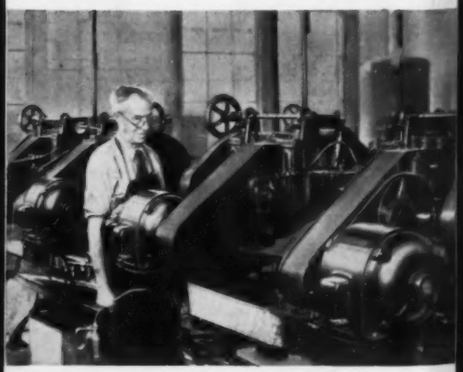
WET JOB Here's a Tri-Clad splash-proof motor close to the floor. Special end shields, watertight conduit boxes, and Formex wire give it *extra* protection against moisture.



HOT JOB These stoker motors are down where red-faced firemen used to sweat. Double-end ventilation and Formex windings with high-heat-transfer advantages give it *extra* protection needed for this service.



HEAVY JOB This Tri-Clad motor is installed on a lift bridge. In these surroundings where grease and grime are ever present, a protective frame is an important factor in continuous operation.



RUSH JOB Here's a Tri-Clad motor at work in the arms industry. The many features of Tri-Clad motors can not only help plants to get important tools into production quickly but will also help keep them in triple-shift operation.

GENERAL ELECTRIC

750-115-8068